Overview of the Clean Water Act and the National Pollutant Discharge Elimination System (NPDES) Program

EPA

Clean Water Program Development

- 1899 Rivers and Harbors Act
- 1948 Federal Water Pollution Control Act (FWPCA)
- 1965 Water Quality Act
- 1970 Executive Order - EPA established
- 1970 Refuse Act Permit Program
- 1972 FWPCA Amendments
- 1977 Clean Water Act (CWA)
- 1987 Water Quality Act

EPA

Water Quality Act of 1965

- Required standards for interstate waters
- Enforcement hampered by
  - Burden of proof with enforcing agency
  - Lack of standards
  - No criminal or civil penalties

Refuse Act Permit Program (RAPP)

- Joint program of the Corps of Engineers and EPA
- Required permits for discharges to public waterways
- No criteria for making permitting decisions
- Struck down by a Federal court in 1971

EPA

Federal Water Pollution Control Act Amendments - 1972

Section 101(a)

- **Objective:** Restore and maintain the chemical, physical, and biological integrity of the nation's waters
- **National Goals**
  - Eliminate the discharge of pollutants by 1985
  - Achieve by July 1, 1983, as an interim goal, a level of water quality that provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water

EPA

Federal Water Pollution Control Act Amendments - 1972 (Continued)

- Established NPDES, pretreatment, and construction grants programs
- Established compliance dates
- Provided for authorization of State NPDES permitting programs
- Indicated that permit compliance is a shield
- Established significant penalties for permit violations

EPA

Natural Resources Defense Council Consent Decree - 1976

- Required a list of toxic priority pollutants
- Required a list of primary industries for technology-based controls

Clean Water Act - 1977

- Section 307(a) adopted provisions of NRDC Consent Decree
- Clarified that Federal facilities are subject to State programs
- Pretreatment program delegation
  - Authorized EPA to approve local pretreatment program
  - Required NPDES States to modify programs to include pretreatment oversight

EPA

Water Quality Act - 1987

- Specifies storm water permitting requirements
- Designates that Indian tribes be considered “States”
- Creates Federal sludge management program
- Increases penalties for noncompliance
- Renews emphasis of surface water toxics control

EPA

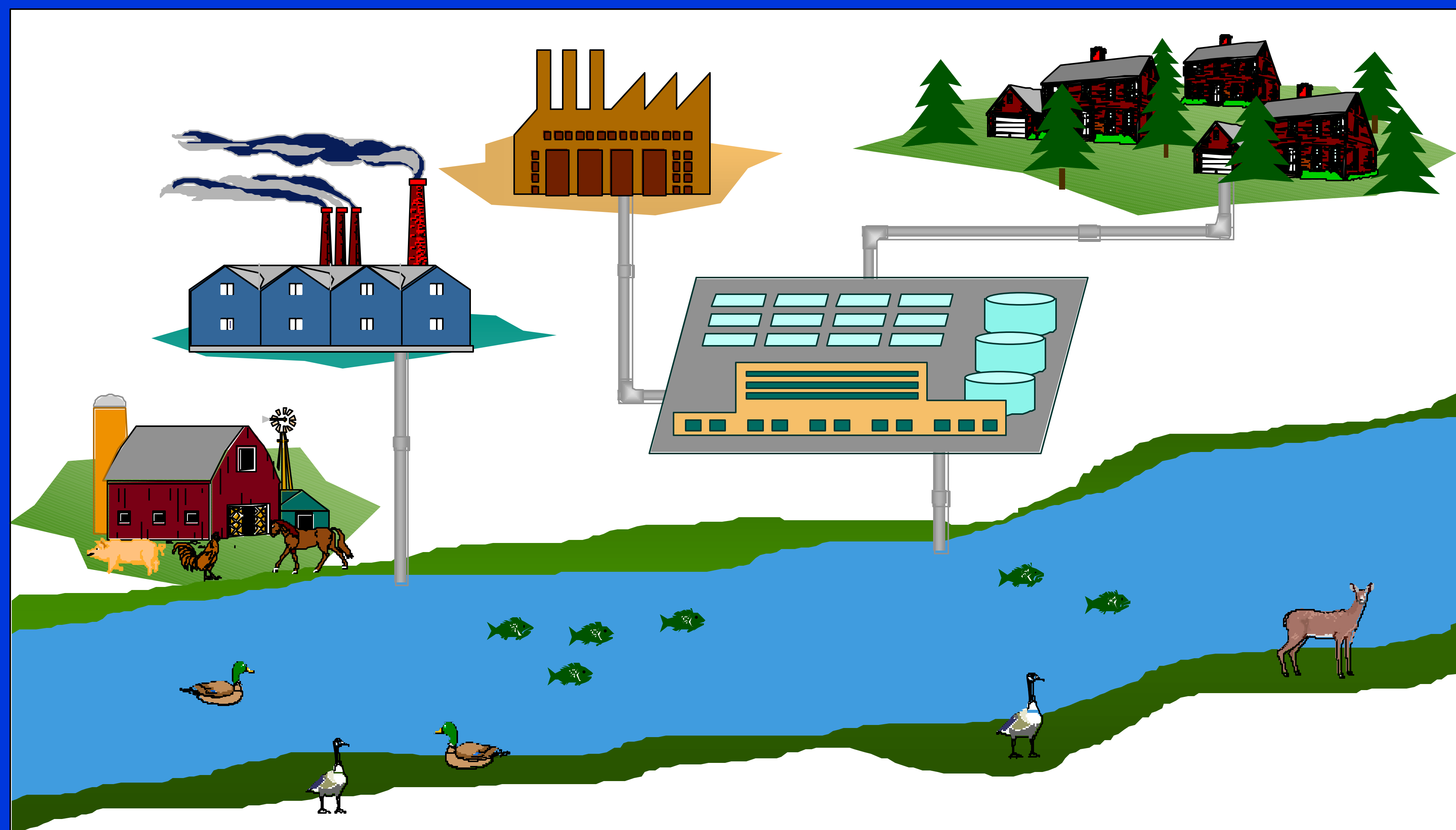
NPDES Statutory Framework

- All "point" sources
- "Discharging pollutants"
- Into "waters of the U.S."

Must obtain an NPDES permit from EPA or an approved State

EPA

NPDES Permit Program



Distribution of Dischargers*

Majors	Type of Facility	Minors
4,095	Municipal	11,278
2,654	Non-Municipal	40,278
624	Federal	1,991
7,373	Total	53,547

60,920 Individual Permits

18,366 Applications with Permits Not Issued

***As of 2/22/01**

EPA

CWA Classes of Pollutants

- Conventional pollutants
  - BOD
  - TSS
  - Oil and Grease
  - Fecal Coliforms
  - pH
- Toxic pollutants
  - Heavy metals
    - Copper
    - Lead
    - Zinc
    - Nickel
    - Chromium
    - Etc.

EPA

CWA Classes of Pollutants (Continued)

- **Toxic pollutants (Cont'd)**
  - Organic chemicals
    - Benzene
    - 1, 2 - Dichlorobenzene
    - Carbon tetrachloride
    - Etc.
- **Nonconventional pollutants**
  - Ammonia
  - Chlorine
  - Toxicity
  - Etc.

Waters of the United States
40 CFR §122.2

- Regulatory definition would cover virtually all types of surface waters including:
  - Rivers and streams
  - Lakes and ponds
  - Wetlands
  - Sloughs
  - Prairie potholes
  - Intermittent streams
  - Territorial seas
  - Etc.

EPA

Waters of the US (continued)

- SWANCC v. US Army COE (January 9, 2001)
  - What's in?
    - Navigable waters
    - Interstate waters
    - Waters adjacent to or part of the tributary system of navigable waters (part of the same aquatic system)
    - Waters used or that could be used for interstate commerce*
  - What's out?*
    - Isolated, intrastate waters that could affect interstate commerce solely by virtue of their use as migratory bird habitat
  - What if you are not sure?
    - Call EPA

Waters of the US (continued)

- What about groundwater?
  - May be if a direct hydrological connection
  - May be "Waters of the State"
- What about treatment ponds or lagoons?

EPA

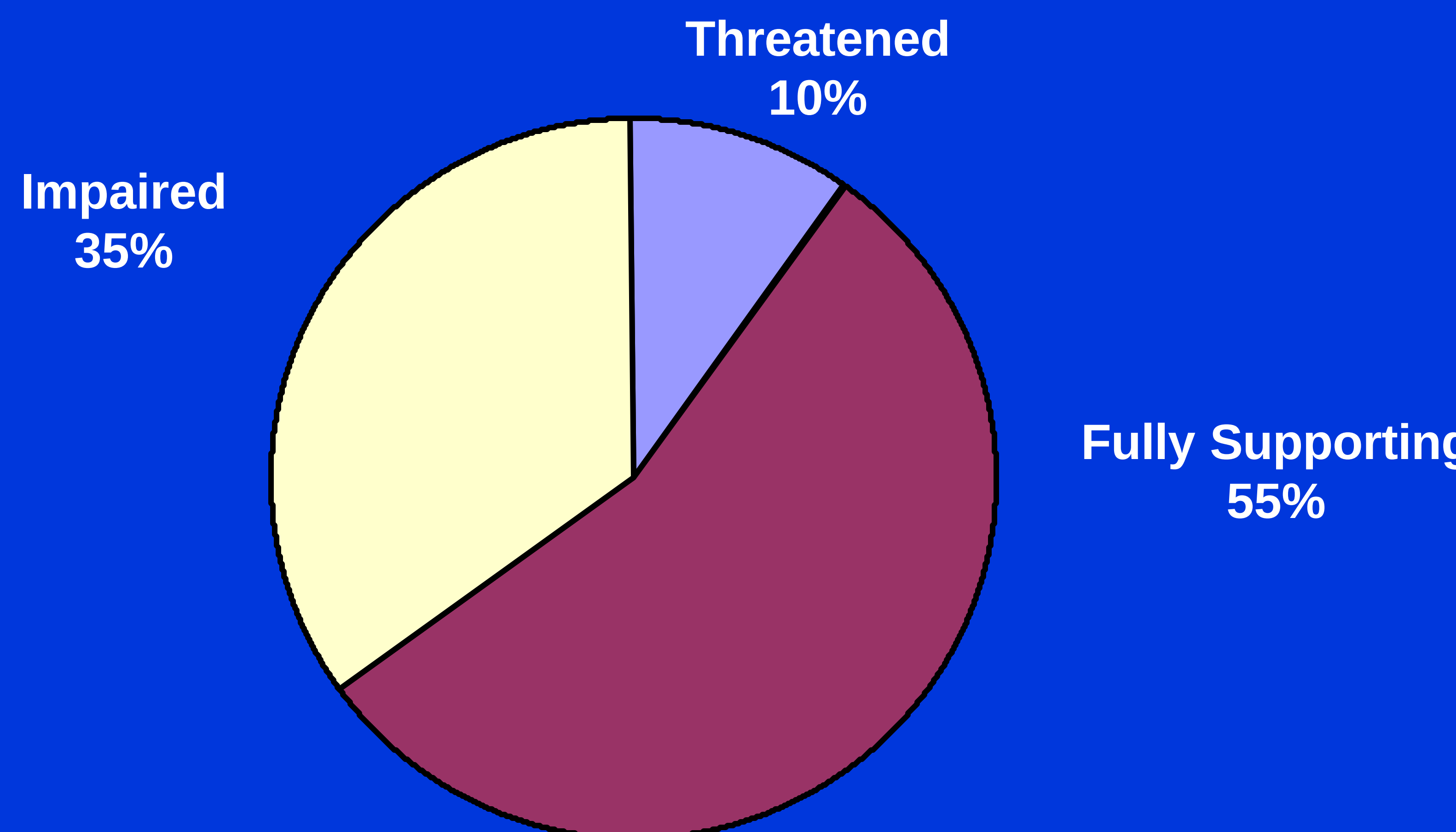
NPDES Accomplishments to Date

Since 1972:

- **$70 Billion - POTW Construction**
- **Pollutant loads reduced from 7 to 4.3 thousand tons per day**
- **Water bodies meeting standards increased from 37% to 55%**

EPA

Rivers and Streams*



*** 842,426 of 3.6 million miles assessed.**

Source: 1998 State 305(b) reports

Scope and Regulatory Framework of the NPDES Program

Learning Objectives

- Define scope of NPDES program
- Describe NPDES regulatory framework
- Explain role of EPA and State/Tribal Authorities
- Provide program status

EPA

General Definitions

- Clean Water Act Legislation
- NPDES Regulations
- Policy and Guidance

EPA

NPDES Regulation

- Code of Federal Regulations (CFR)
  - Where regulations promulgated in FR are published annually
  - Title 40: Protection of Environment

NPDES Regulations (Continued)

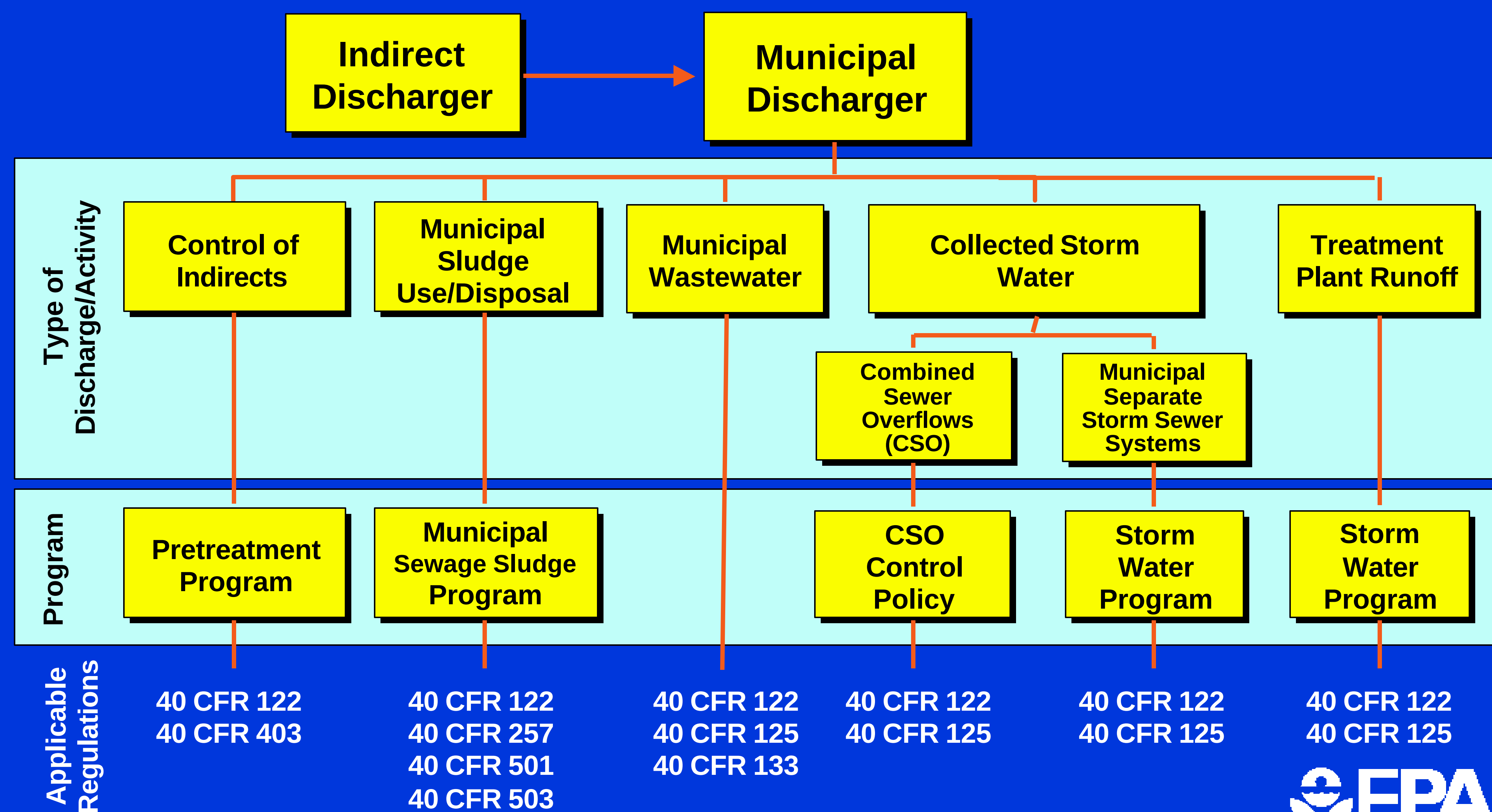
- Federal Register (FR)
  - Where rules are first proposed and then promulgated
  - Includes background information (i.e., preamble)
  - Published daily

Key NPDES Regulations

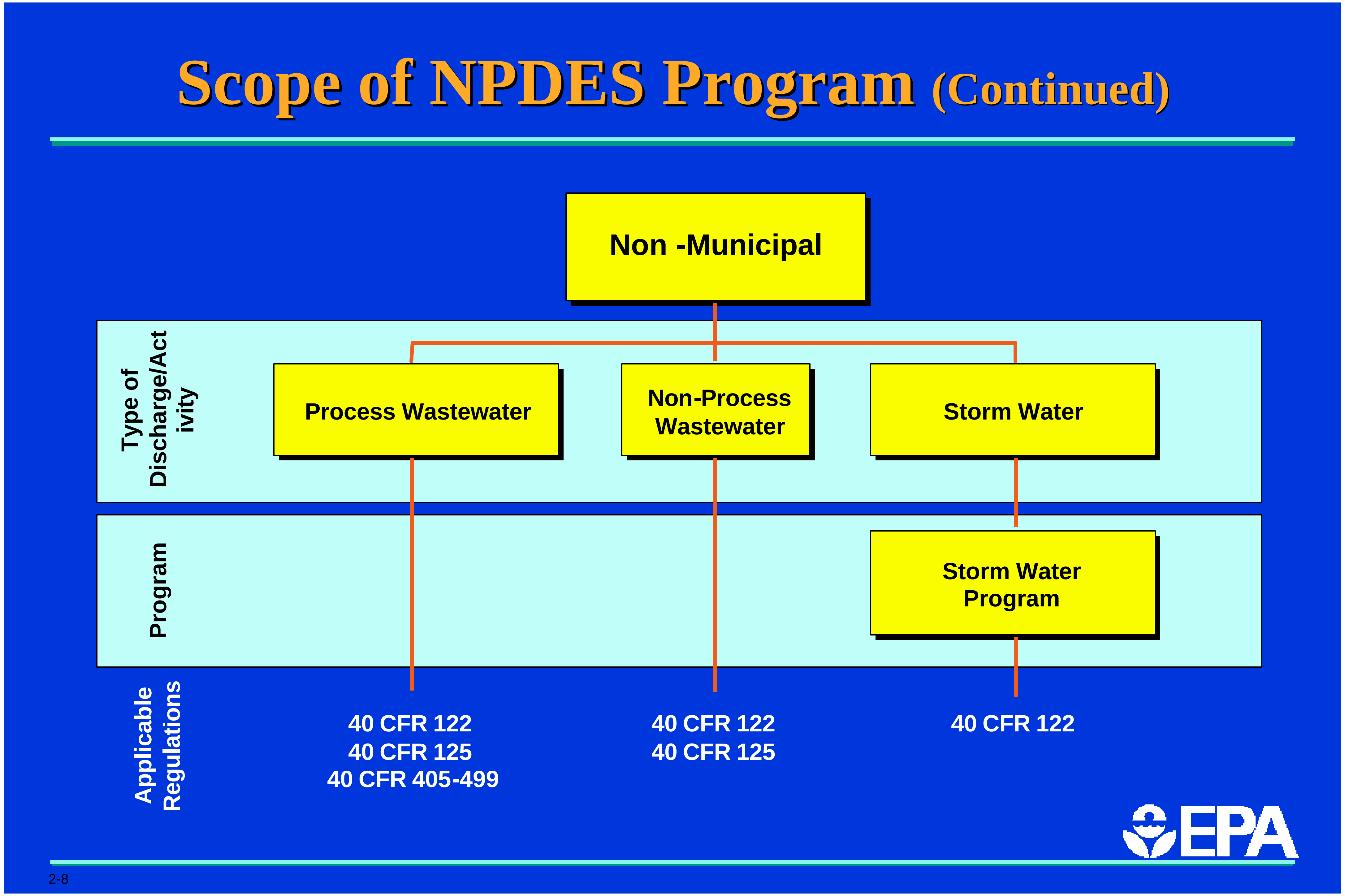
40 CFR Part	Description
121	State Certification of Activities Requiring a Federal License or Permit
122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System
123	State Program Requirements
124	Procedures for Decisionmaking
125	Criteria and Standards for the National Pollutant Discharge Elimination System
129	Toxic Pollutant Effluent Standards
130	Water Quality Planning and Management
131	Water Quality Standards
132	Water Quality Guidance for the Great Lakes System
133	Secondary Treatment Regulation
136	Guidelines for Establishing Test Procedures for the Analysis of Pollutants
401	General Provisions
403	General Pretreatment Regulations
405-499	Effluent Limitations Guidelines and Standards

EPA

Scope of NPDES Program



EPA


Scope of NPDES Program (Continued)
Non -Municipal
Type of Discharge/Activity
Process Wastewater
Non-Process Wastewater
Storm Water
Program
Storm Water Program
Applicable Regulations
40 CFR 122
40 CFR 125
40 CFR 405-499
40 CFR 122
40 CFR 125
40 CFR 122
EPA
2-8

NPDES Implementation

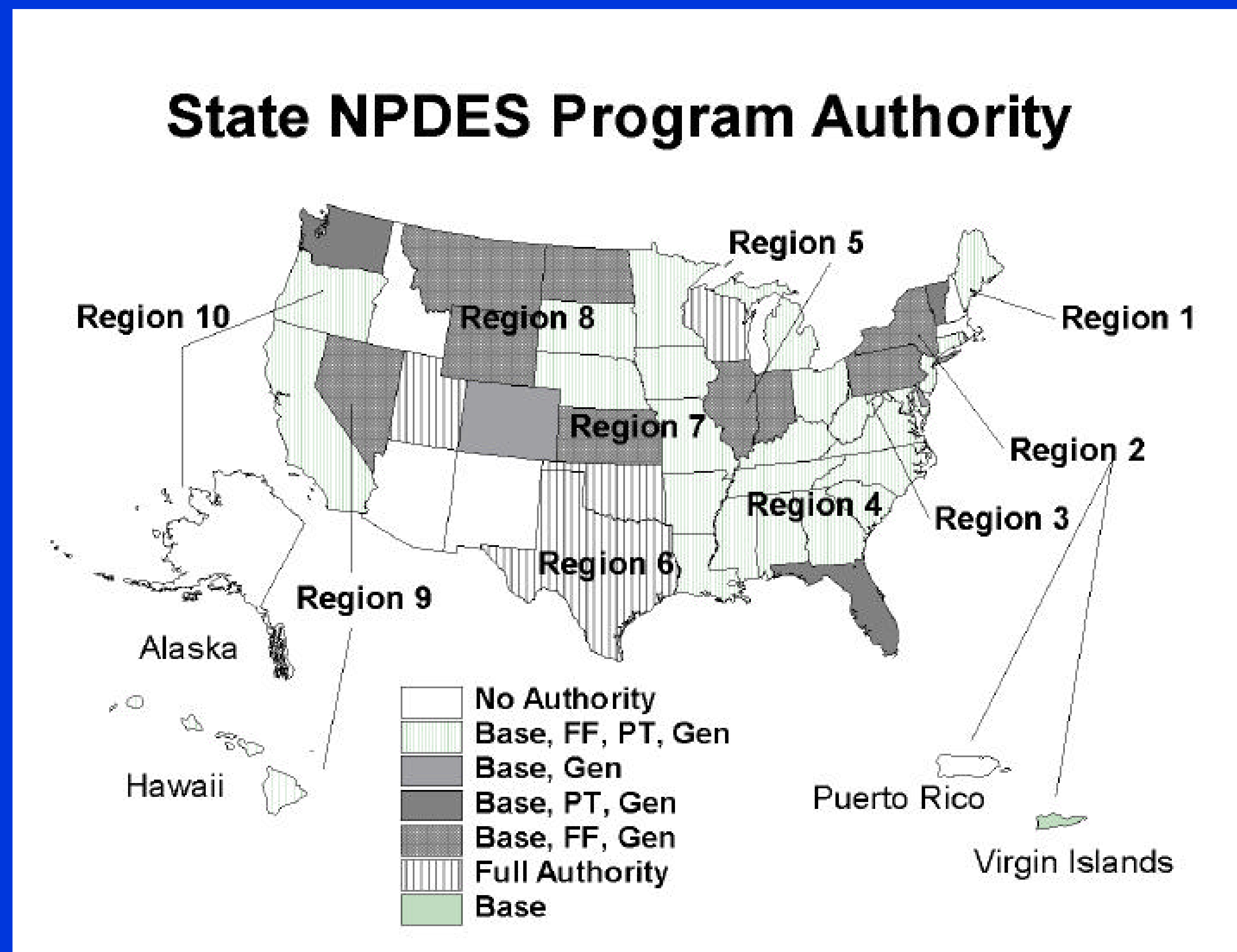
- Before State/Tribal program approval:
  - EPA issues permits
  - EPA conducts compliance and monitoring activities
  - EPA enforces
- After State/Tribal program approval:
  - States implement as above
  - EPA role = oversight
    - Grants
    - Administrative, technical and legal support and training
    - Enforcement as necessary

EPA

Types of NPDES Authorization

1. Basic Municipal and Industrial Permit Program
2. Pretreatment Program
3. Federal Facilities Program
4. General Permit Program
5. Sludge Permit Program

Map of Authorization



NPDES Permits: Types, Components, and Issuance Process

Learning Objectives

- Describe NPDES permit types
- Discuss major components of NPDES permit
- Describe the overall permit issuance process

EPA

What is a Permit?

- It is a license . . .
  - Issued by the government to persons conducting business in the United States
  - Granting permission to do something which would be illegal in the absence of the permit
- There is no right to a permit and it is revocable for cause (noncompliance)
- For our purposes, NPDES permit is license to discharge

EPA

Types of NPDES Permits

- **Individual**
  - **1 application submitted □ 1 permit issued**
- **General**
  - **1 permit issued □ many applications submitted**
  - **Issued on an area-wide (State, watershed, etc.) basis**
  - **Available when:**
    - **Same or similar operations**
    - **Discharge same wastes**

Individual Permit Issuance Process

Permit Application

Permit and Fact Sheet Development

- Effluent Limits
- Monitoring Conditions
- Standard Conditions
- Special Conditions

Public Notice and Public Comments

Administrative Record

Final Permit

General Permit Issuance Process

Identify Need and Collect Data

↓

Permit and Fact Sheet Development
- Effluent Limits
- Monitoring Conditions
- Standard Conditions
- Special Conditions

↓

Public Notice and Public Comments

↓

Administrative Record

↓

Final Permit

↓

Notice of Intent to be Covered

Permit Components

Industry-Specific Components

- Effluent Guidelines
- BPJ

- BMPs

Components of All Permits

Cover Page

Effluent Limitations

Technology-Based

Water Quality-Based

Monitoring & Reporting Requirements

Special Conditions

Compliance Schedules

Storm Water

Special Studies, Evaluations, and Other Requirements

Standard Conditions

Municipal-Specific Components

- Secondary
- Equivalent to Secondary

- Pretreatment
- CSOs
- Municipal Sewage Sludge

The Permit Application Process

Learning Objectives

- 40 CFR 122.21 - Application for a permit
- Who must submit permit applications?
- When are applications due?
- What forms and information are required for permit applications?
- What are the responsibilities of the permit writer?

Who Must Apply for a Permit

- Anyone who discharges pollutants or proposes to discharge pollutants to waters of the U.S.
  - Signatories - 40 CFR 122.22
- Exceptions include:
  - Dredged or fill materials
  - Some marine vessel discharges (e.g., laundry, shower, etc.)
  - Non-point source runoff
  - Indirect dischargers to POTWs

When to Apply

Type of Permit	Type of Discharger		Schedule*
Individual	New	Discharger	180 days before date of discharge commencement
		Source	
	Existing		180 days before expiration of existing permit
General	New		Specified in general permit
	Existing		X number of days following issuance of general permit

* Authorized States may use more stringent deadlines.

Additional Requirement for New Sources

- Where EPA issues permit and finds the permit to be a major Federal action affecting the quality of the human environment as defined under the National Environmental Policy Act (NEPA)
  - EPA determines whether an environmental impact statement (EIS) is required pursuant to NEPA
  - EIS includes recommendation to issue or deny the permit
- EPA not required to conduct NEPA review for a state-issued permit, but state environmental policy act may have similar requirements.

EPA Application Forms for NPDES Individual Permits

Form	Title/Applicability	Regulation Cite
1	General Information	122.21(f)
2A	New and existing POTWs	122.21(j)
2S	Treatment Works Treating Domestic Sewage (TWTDS)	122.21(q)
2B	New and existing animal feeding operations and aquatic animal production facilities	122.21(i)
2C	Existing manufacturing, commercial, mining, and silvicultural discharges	122.21(g)
2D	New manufacturing, commercial, mining, and silvicultural discharges	122.21(k)

EPA

EPA Application Forms for NPDES Individual Permits (Continued)

Form	Title/Applicability	Regulation Cite
2E	Manufacturing, commercial, mining, and silvicultural facilities that discharge only non-process wastewater	122.21(h)
2F	Stormwater discharges associated with industrial activities & discharges associated with small construction activity (no later than March 2003)	122.26(c)
None	Stormwater discharges from large and medium MS4s	122.26(d)
None	Stormwater discharges from small MS4s (no later than March 2003)	122.33

Major Components of Form 2C

I. Outfall location

II. Flow, sources of pollution, treatment technologies

III. Production information (if applicable)

IV. Improvements (if applicable)

V. Intake and effluent characteristics

VI. Potential discharges not covered by analysis

VII. Biological testing data

VIII. Contract analysis information

IX. Certification/signature

Intake and Effluent Characteristics
Form 2C, Section V

- “Part A” conventional and non-conventional pollutants including BOD, COD, TOC, TSS, NH3, flow, temperature, pH
- “Part B” conventional and non-conventional pollutants (e.g., oil and grease, radioactivity, color, etc.)

EPA

Intake and Effluent Characteristics Form 2C, Section V (Continued)

- "Part C" Priority Pollutants
  - Metals, total cyanide, and total phenols
  - 2, 3, 7, 8-TCDD (dioxin)
  - Toxic Organic Pollutants
    - Volatile compounds
    - Acid compounds
    - Base/neutral compounds
    - Pesticides

Primary Industries and Required GC/MS Fractions

Industry Category	GC/MS Fraction			
	Volatile	Acid	Base/Neutral	Pesticide
Adhesives and sealants	X	X	X	–
Aluminum forming	X	X	X	–
Auto and other laundries	X	X	X	X
Battery manufacturing	X	–	X	–
Coal mining	–	–	–	–
Coil coating	X	X	X	–
Copper forming	X	X	X	–
Electric and electronic compounds	X	X	X	X
Electroplating	X	X	X	–
Explosives manufacturing	–	X	X	–
Foundries	X	X	X	–
Gum and wood (all subparts except D and F)	X	X	X	X
Subpart D - tall oil rosin	X	X	X	–
Subpart F - rosin-based derivations	X	X	X	–
Inorganic chemicals manufacturing	X	X	X	–
Iron and steel manufacturing	X	X	X	–
Leather tanning and finishing	X	X	X	X
Mechanical products manufacturing	X	X	X	–
Nonferrous metals manufacturing	X	X	X	X

Primary Industries and Required GC/MS Fractions (Continued)

Industry Category	GC/MS Fraction			
	Volatile	Acid	Base/Neutral	Pesticide
Ore mining (applies to the base and precious metals/Subpart B)	–	X	–	–
Organic chemicals manufacturing	X	X	X	–
Paint and ink formulation	X	X	X	X
Pesticides	X	X	X	X
Petroleum refining	X	–	–	–
Pharmaceutical preparations	X	X	X	–
Photographic equipment and supplies	X	X	X	X
Plastic and synthetic materials manufacturing	X	X	X	X
Plastic processing	X	–	–	–
Porcelain enameling	–	–	–	–
Printing and publishing	X	X	X	X
Pulp and paperboard mills (see footnote 2)	X	X	X	X
Rubber processing	X	X	X	–
Soap and detergent manufacturing	X	X	X	–
Steam electric power plants	X	X	X	–
Textile mills (Subpart C-Greige Mills are exempt)	X	X	X	X
Timber products processing	X	X	X	X

Responsibility of Permit Writer

- Verify completeness of application
- Verify accuracy of application

Reviewing Permit Applications

- Are all spaces filled in, including N/A where appropriate?
- Do the concentration, mass and flow values accurately characterize the discharge?
- Are the reported values consistent with historical information?
- Do concentration values correspond with analytical detection limits?
- Are signatory and certification requirements fulfilled (40 CFR §122.22)?

Common Omissions

- Map required in Form 1
- Flow diagram required in Form 2C
- Required metals
- Required GC/MS fractions for Primary Industry
- Expected toxics and other pollutants
- Production rates

EPA

Obtaining Additional Information

- Telephone can be used to obtain required or supplemental information (add note to permit file)
- Permit writer may request that applicant submit changes in writing
- Permit writer may request that applicant submit a new application to address deficiencies

EPA

Other Useful Information

- Review DMRs, STORET or PCS data
- Review previous applications or inspection reports
- Review development documents, EPA Treatability Manual, State Water Quality Standards
- Look for information on other permits (e.g., RCRA hazardous waste or air permits)

Technology-Based Effluent Limits

Learning Objectives

- Explain the purpose of technology-based requirements
- Describe the types of technology-based requirements

Technology-Based Requirements

- **Purpose**
  - Establish minimum level of pollutant controls for all point source dischargers
    - Conventional pollutants
    - Non-conventional pollutants
    - Toxic pollutants
  - Provide equity among dischargers within categories

Technology-Based Requirements

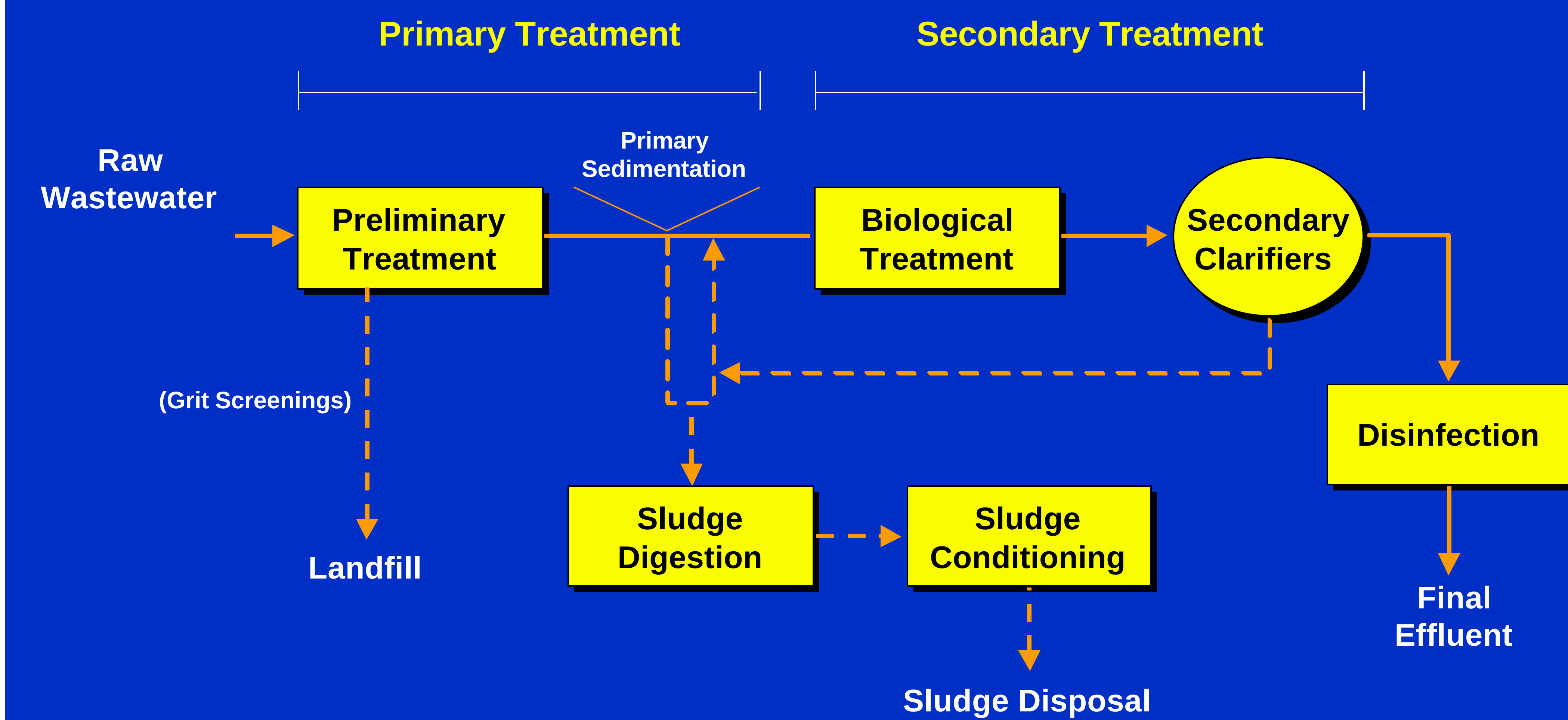
- Technology-based requirements implemented through NPDES permits
- National technology-based standards are available
  - Effluent guidelines for non-municipal
  - Secondary treatment standards for municipal
- In the absence of National standards
  - Technology-based requirements developed on a case-by-case basis

Technology-Based Effluent Limits for Municipal Dischargers

Learning Objectives

- Describe secondary treatment regulations
- Explain equivalent to secondary requirements

Flow Diagram of a Wastewater Treatment Plant



Technology-Based Requirements for Municipal Dischargers Secondary Treatment

	30 Day Average	7 Day Average
5-Day BOD	30 mg/l	45 mg/l
TSS	30 mg/l	45 mg/l
pH	6 – 9	––
Removal	85% BOD_5 and TSS	––

(40 CFR Part 133)

Note: Compliance Deadline = 7/1/88

EPA

Calculation of Permit Limits

- Must be concentration-based because secondary treatment standards are expressed in concentration units
  (40 CFR § 122.45 (f)(1)(ii))
- May also be mass-based
  - If mass-based, use design flow of the treatment plant (40 CFR § 122.45(b))

EPA

Calculation of Permit Limits (Continued)

Example calculation:

5 day BOD: 30 day average = 30 mg/L

POTW Design Flow = 5.0 mgd

BOD Limit = (5 mgd)(30 mg/L)(8.34*) = 1,251 lbs/day

* 8.34 is the conversion factor

What if:

POTW Actual Flow = 7 mgd ?

POTW Actual Flow = 2.5 mgd ?

Exceptions/Alternatives to Secondary Treatment Requirements

- Substitution of $CBOD_5$ for BOD_5 [133.102(a)(4)]
- Adjustments to reflect:
  - Wet weather
  - Combined sewers [133.103(a)]
  - Industrial wastes [133.103(b)]
  - Waste stabilization ponds [133.103(c)]
  - Less concentrated influent for separate sewers [133.103(d)]
  - Less concentrated influent for combined sewers [133.103(e)]
- Substitution of COD or TOC for BOD_5 [133.104(b)]

EPA

Exceptions/Alternatives to Secondary Treatment Requirements

- Treatment equivalent to secondary
- Waiver from secondary treatment for marine discharges

Equivalent to Secondary

- Must be trickling filter or waste stabilization pond (lagoon)
- Biological treatment ³ 51% of treatment
- Plant exceeds 30/30 with proper O&M
- Water quality not adversely affected
- Equivalent to secondary limits:
  - Up to 45 mg/l (30 day average)
  - Up to 65 mg/l (7 day average)
  - Not less than 65% removal
- Guidance distributed December 1985

Conditions to Consider in Applying Equivalent to Secondary Effluent Limitations

- Treatment works operating beyond the design hydraulic capacity or organic loading limit are not considered eligible for equivalent to secondary limitations
- New facilities

Conditions to Consider in Applying Equivalent to Secondary Effluent Limitations (Continued)

- Calculation of equivalent to secondary limitations
- Combination of biological treatment processes employed at a facility
- Alternative State Requirements (ASRs)

Sources of Facility Information

- Application Form 1 and Form 2A
- Supplemental information (sludge, toxicity, CSOs, pretreatment)
- Discharge Monitoring Reports (DMRs)
- Pretreatment program submissions
- Annual pretreatment reports
- Pretreatment audits

EPA

Effluent Limitations Guidelines for Non-Municipal Dischargers

Learning Objectives

- Describe process used in developing effluent limitations guidelines
- Discuss considerations in applying effluent guidelines
- Explain application of effluent guidelines

EPA

Effluent Limitations Guidelines

- Definition
  - Effluent limitations guidelines are National standards prescribing allowable discharges of pollutants from industrial point source categories corresponding to various levels of treatment or control technologies
- Scope
  - Guidelines are established for most primary and some secondary industries

EPA

CWA Technology-Based Control Matrix

Technology-Based Control Level	Type of Discharger	Conventional	Non-Conventional	Toxic
Best Practicable Control Technology Currently Available (BPT)	Direct	X	X	X
Best Conventional Pollutant Control Technology (BCT)	Direct	X		
Best Available Control Technology Economically Achievable (BAT)	Direct		X	X
New Source Performance Standards	Direct	X	X	X
Pretreatment Standards for Existing Sources (PSES)	Indirect	X	X	X
Pretreatment Standards for New Sources (PSNS)	Indirect	X	X	X

Type of Discharger: Key Definitions

- New Source – Any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which commenced:
  - After promulgation of effluent limitations guidelines and standards applicable to such source, or
  - After proposal of effluent limitations guidelines and standards, but only if the standards are promulgated within 120 days of proposal

Additional New Source Determination Criteria

- Constructed at a site at which no other source is located; or
- Totally replaces the process causing the discharge from an existing source; or
- Processes are substantially independent of an existing source at the same site; and
- A new source performance standard is independently applicable to the discharge

Type of Discharger: Key Definitions
(Continued)

- **Existing Source – Any building, structure, facility, or installation from which there is or may be a discharge of pollutants which is not a new discharger or new source**

Statutory Compliance Deadlines for Technology-Based Requirements

Pollutant Category	Level of Treatment	Compliance Deadline
Conventional	BPT	July 1, 1977
Conventional	BCT	March 31, 1989
Non-conventional	BPT	July 1 1977
Non-conventional	BAT	March 31, 1989
Toxic	BPT	July 1, 1977
Toxic	BAT	March 31, 1989

EPA

Effluent Limitations Guidelines (Continued)

- CWA Section 304(m)
  - Guidelines may be developed for new or additional industries, such as:
    - Centralized waste treatment
    - Transportation equipment cleaning
    - Industrial laundries
    - Metal products and machinery manufacturers

Implementing Effluent Guidelines

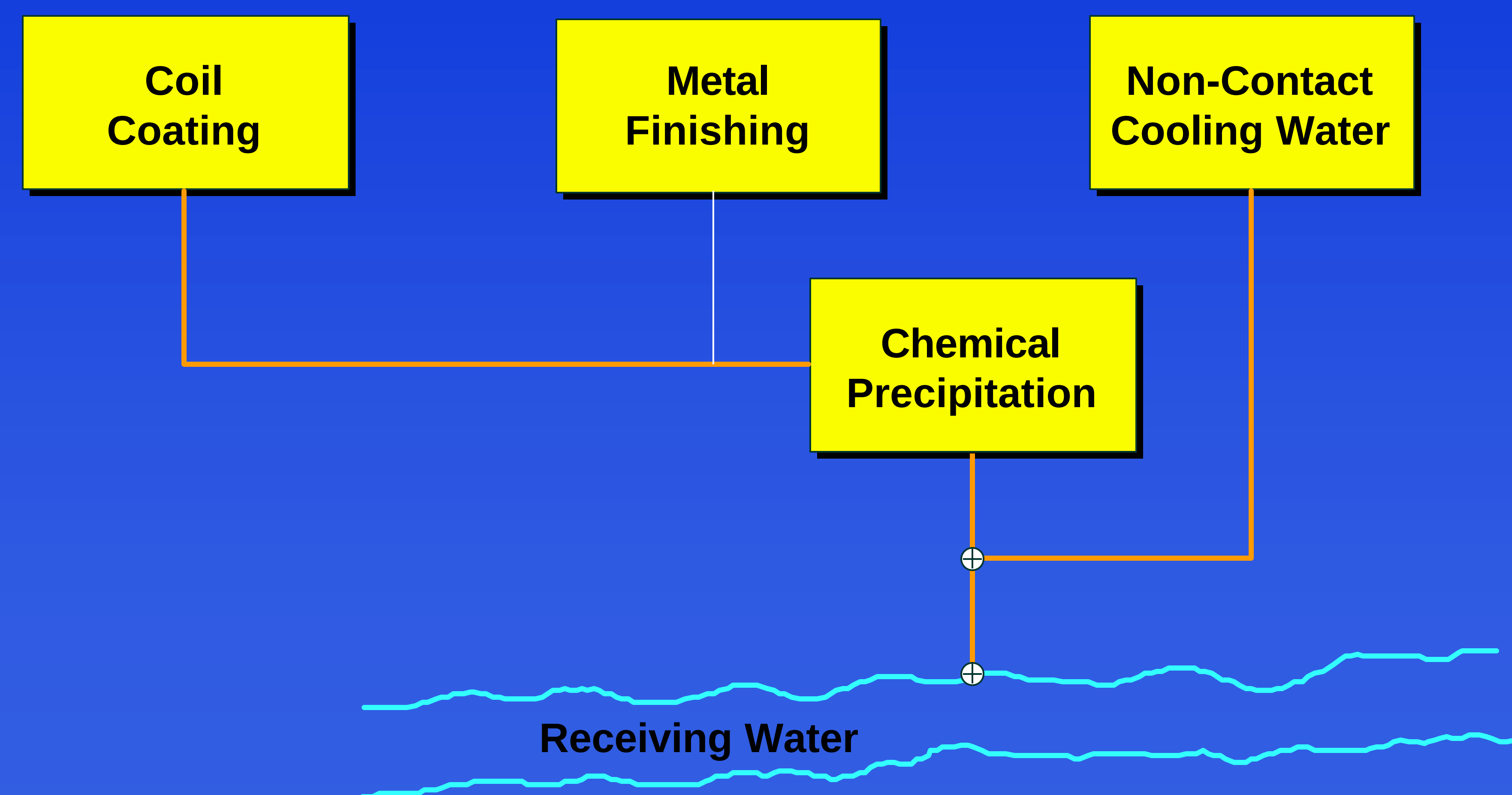
- Effluent guidelines
  - Implemented and enforced through NPDES permits
  - Serve as the basis for technology-based limits

Considerations Involved in Use of Effluent Guidelines

- Determination of proper category and subcategory
  - Applicability section in regulation
  - Preamble to regulation
  - SIC Code(s)
    (e.g., Copper Forming = SIC Code 3351)
  - Development documents

Considerations Involved in Use of Effluent Guidelines (Continued)

Example 1:



Considerations Involved in Use of Effluent Guidelines (Continued)

- Classification of plants that fall under more than one category
  - Must apply all applicable effluent guidelines
  - Some guidelines supercede others
  - Considerations for common treatment systems
    - BPJ for non-regulated pollutants
    - Account for dilution from non-regulated wastestreams
  - Inconsistent limits expressions (units)
  - Use internal outfalls

Considerations Involved in Use of Effluent Guidelines (Continued)

Example 2:

Coil Coating	**mg/m^2**
Metal Finishing:	**mg/L**
Ferroalloy Manufacturing:	**kg/mwh**

Considerations Involved in Use of Effluent Guidelines (Continued)

- Determination of appropriate measures of production and flow
  - Use reasonable measure of <u>actual</u> production and flow rate
  - Long-term average expected during the term of permit
  - Account for planned changes
  - Time period of measurement
    - Daily maximum production/flow → Daily maximum limit
    - Average monthly production/flow → Monthly average limit

Considerations Involved in Use of Effluent Guidelines (Continued)

- Use of alternative or tiered limits
  - To account for variability of production/flow (e.g., seasonal)
  - Significant = > 20%
  - Requires careful examination of production data
  - Requires special reporting requirements
    - Notification of changed production/flow
    - Reporting of production data

EPA

Considerations Involved in Use of Effluent Guidelines (Continued)

- Application of effluent guidelines in permits
  - Include all regulated pollutants
  - Parameters considered by effluent guideline but not regulated by effluent guideline
  - Include both daily maximum and monthly average limits
  - Express as mass limits unless guideline allows, or parameter requires concentration-based limit

EPA

Best Professional Judgment-based Permit Limits

Learning Objectives

- Provide overview of BPJ derived limits
- Describe examples of BPJ application
- Discuss BPJ technical and economic considerations
- Present BPJ tools and resources

BPJ Is the Permit Writer's Opinion

- Technology-based NPDES permit conditions, developed using all reasonable available and relevant data
- Why? Technology-based effluent limits must be established for all pollutants regulated in a permit
- When? On a case-by-case basis in the absence of effluent guidelines and standards for a facility or pollutant

EPA

Hypothetical Situation for Use of BPJ

Pollutants to be Regulated in Permit	Considered/Regulated by Effluent Guidelines and Standards?	BPJ Effluent Limit Needed?
Copper	Yes	No
Zinc	Yes	No
Benzene	No	Yes
Aluminum	No	Yes

BPJ Application Examples

- Combined sewer overflows
- Hazardous waste treaters
- Equipment manufacturers
- Waste oil reclaimers
- Industrial laundries
- Paint and ink facilities
- Pharmaceuticals
- Barrel reclaimers
- Transportation facilities
- Mining operations
- Water treatment plants
- Petroleum industry

EPA

CWA Technology-Based Control Matrix

Technology-Based Control Level	Type of Discharger	Conventional	Non-Conventional	Toxic
Best Practicable Control Technology Currently Available (BPT)	Direct	X	X	X
Best Conventional Pollutant Control Technology (BCT)	Direct	X		
Best Available Control Technology Economically Achievable (BAT)	Direct		X	X
New Source Performance Standards	Direct	X	X	X
Pretreatment Standards for Existing Sources (PSES)	Indirect	X	X	X
Pretreatment Standards for New Sources (PSNS)	Indirect	X	X	X

EPA

BPJ Considerations

- For BPT requirements:
  - Total cost of technology in relation to the effluent reduction benefits to be achieved from such application
  - Age of equipment and facilities involved
  - Process(es) employed
  - Engineering aspects of the application of various types of control techniques
  - Process changes
  - Non-water quality environmental impact including energy requirements

EPA

BPJ Considerations

- For BCT requirements:
  - Reasonableness of the relationship between costs of attaining reduction in effluent and the derived effluent reduction benefits
  - Comparison of the cost and level of reduction of such pollutants from publicly owned treatment works to the cost and level of reduction from a class or category of industrial sources

BPJ Considerations

- **BCT requirements (continued):**
  - Age of equipment and facilities involved
  - Process(es) employed
  - Engineering aspects of the application of various types of control techniques
  - Non-water quality environmental impact including energy requirements
  - Process changes

BPJ Considerations

- For BAT requirements:
  - Age of equipment and facilities involved
  - Process(es) employed
  - Engineering aspects of the application of various types of control techniques
  - Process changes
  - Cost of achieving effluent reduction
  - Non-water quality environmental impact including energy requirements

Cost Considerations

Proposed Treatment Option	A	B	C
Influent Concentration	10	10	10
Effluent Concentration	5	2	6
Lbs Removed	150	240	120
Treatment Cost ($)	600	2400	240
<u>BPT</u> ($/lb)	4	10	2
<u>BAT</u> (Economically Achievable?)	Yes	No	Yes

BPJ Defensibility

- Defensibility depends on reasonableness
- Reasonableness demonstrated by documentation
- Documentation should include:
  - What is being imposed?
  - Why is it being imposed?
  - How it was developed?

EPA

BPJ Tools and Resources

- Abstracts of Industrial NPDES permits
- Treatability Manual and Database
- Technical Support Document for Water Quality-Based Toxics Control
- Economic achievability protocol

BPJ Tools and Resources (Continued)

- Effluent guideline data/information
  - Development documents
  - Proposed regulations
  - Industry summary reports
- Other sources information
  - Model permits
  - Discharge monitoring reports
  - Compliance inspection reports
  - Industry teams/national experts

EPA

Variances to Technology-Based Permit Effluent Limits

Learning Objectives

- Explain role of variances in NPDES permits
- Describe types of variances
- Discuss relief granted by variances
- Describe variance initiation and review processes

Role of Variances in NPDES Permits

- Allows limited relief:
  - effluent limits
  - compliance deadlines
- Address exceptional circumstances
- Provides relief of NPDES program for "unusual" circumstances
- Only granted on rare occasions
- Some may be granted by States, others require EPA approval

Types of Variances

CWA	Type	40 CFR	Approval Authority
301 (c)	Economic Achievability	Part 125, Subpart E (Reserved)	EPA-HQ
301 (g)	Water Quality	Part 125, Subpart F (Reserved)	EPA – Region
301 (h)	Secondary Treatment Waiver-Ocean Discharge (POTW)	Part 125, Subpart G	EPA – HQ
301 (n)	Fundamentally Different Factors (FDF)	Part 125, Subpart D	EPA - Regions
316 (a)	Thermal Discharges	Part 125, Subpart H	NPDES – State*
–	Intake – Discharge Net Basis (Net/Gross)	§122.45 (g)	NPDES State*

* EPA Region in absence of approved state NPDES program

EPA

Initiation of Variance Requests

- Variance applications submitted by the discharger, must be submitted before the close of the public comment period of the permit
- FDF variance requests must be requested by the discharger within 180 days of the guideline promulgation

Overview of Water Quality Standards and Limitations

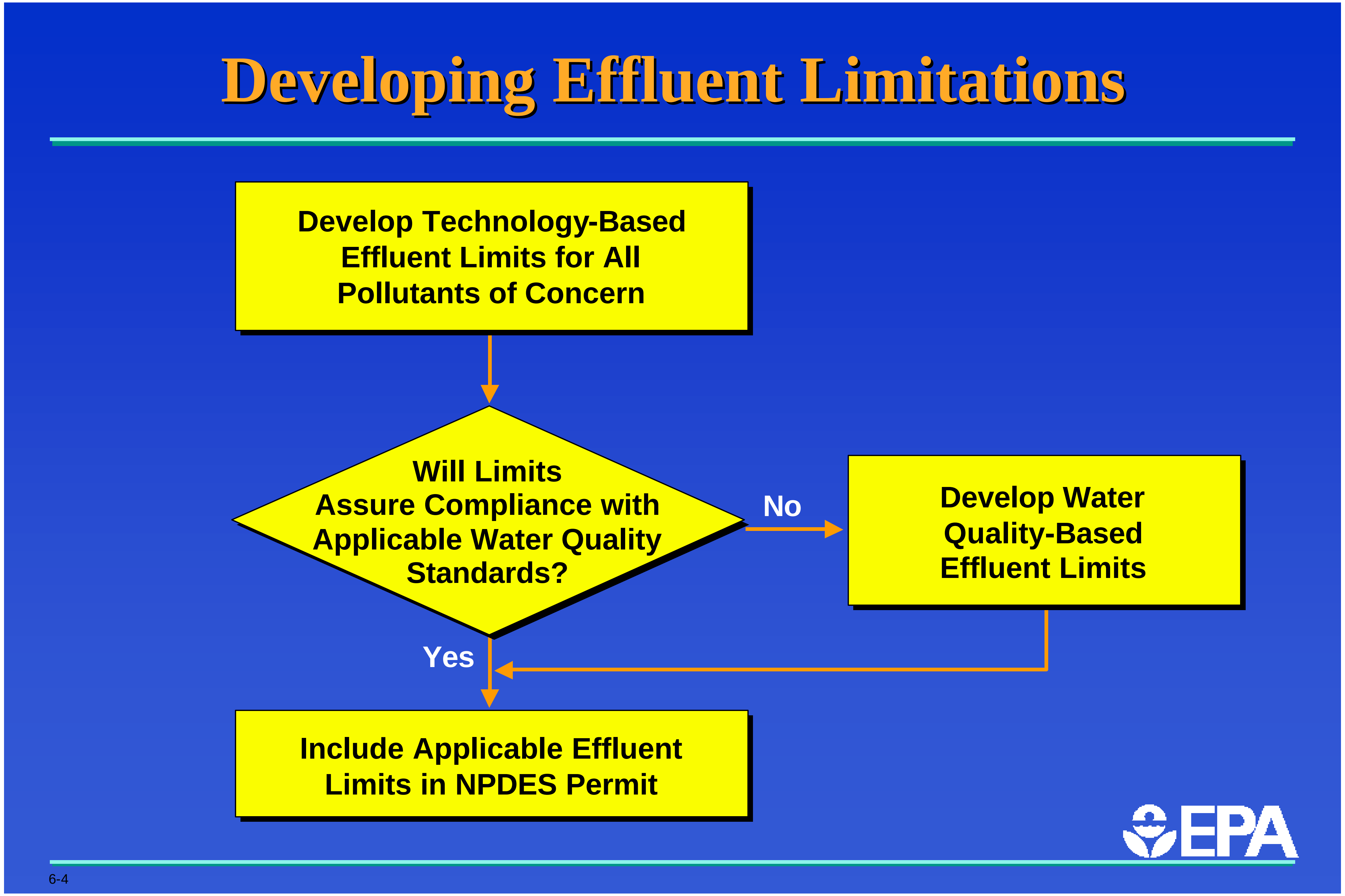
EPA

Learning Objectives

- Provide brief overview of water quality standards
- Discuss the relationship between water quality- and technology-based permitting
- Identify the objectives and components of water quality standards
- Describe the types of water quality criteria
- Explain the relationship between criteria and standards

Clean Water Act Requirements

- **Section 101(a)(2)**
  - Establishes "fishable and swimmable" goal
- **Section 303(c)**
  - Establishes framework for water quality standards program
  - Requires States to establish water quality standards
- **Section 304(a)**
  - Requires EPA to develop and publish water quality criteria
- **Section 301(b)(1)(C)**
  - Requires compliance with limits necessary to meet water quality standards


Developing Effluent Limitations
Develop Technology-Based Effluent Limits for All Pollutants of Concern
Will Limits Assure Compliance with Applicable Water Quality Standards?
No
Develop Water Quality-Based Effluent Limits
Yes
Include Applicable Effluent Limits in NPDES Permit
EPA
6-4

Water Quality Standards - 40 CFR Part 131

40 CFR §131.2

- A water quality standard defines the water quality goals of a waterbody, or portion thereof, by <u>designating the use or uses</u> to be made of the water and <u>by setting criteria</u> necessary to protect the uses.

EPA

Establishing Water Quality Standards

- States and Tribes are responsible for adopting water quality standards for all "waters of the U.S."
  - Water bodies
  - Segments of water bodies
- Standards are reviewed every 3 years (40 CFR §131.20)
- EPA has oversight authority
  - Review and approval (40 CFR §131.5, 131.6, 131.21)
  - Federal promulgation (40 CFR §131.22)

EPA

Components of Water Quality Standards

- **Designated uses** (40 CFR §131.10)
- **Water quality criteria** (40 CFR §131.11)
- **Antidegradation policy** (40 CFR §131.12)

EPA

Designated Uses - 40 CFR §131.10

- Requires that each State specify appropriate uses to be achieved and protected
- Common use categories
  - Public water supply
  - Fish and wildlife propagation
  - Recreation
    - Primary
    - Secondary
  - Agricultural
  - Industrial
  - Navigation

EPA

Designated Uses (Continued)

- Question: What if the designated use is not being attained? Can it be removed from the water quality standards?
- Answer: Depends on the type of use and the basis for the change

EPA

Existing Uses

Existing Uses …

- **are uses actually attained in the water body on or after November 28, 1975**
- **must be reflected in the water quality standards**
- **cannot be removed**

EPA

Removing a Designated Use
40 CFR § 131.10(g)

Designated Uses may be removed if ...

- they are not existing uses
- attaining the use is not feasible, as demonstrated by a Use Attainability Analysis (UAA)

EPA

Water Quality Criteria - 40 CFR §131.11

- Numeric criteria
  - Concentrations of chemicals
  - Aquatic Life
  - Human health
- Narrative criteria
  - Statements that describe the desired water quality goal
  - "Free from…"
    - Toxics in toxic amounts
    - Objectionable color, odor, taste, and turbidity

Types of Numeric Criteria

- **Aquatic Life Criteria**
  - Designed to protect aquatic organisms, including plants and animals
  - Two types
    - Acute
    - Chronic
  - Considers the magnitude, duration, and frequency of exposure to specific pollutants

EPA

Types of Numeric Criteria (Continued)

- Human Health Criteria
  - Single expression of the highest pollutant concentration not expected to pose significant long-term risk to human health
    - Based on chronic exposure via consumption of water and/or aquatic life
    - Accounts for bioconcentration or bioaccumulation

EPA

EPA Water Quality Criteria

- EPA responsible for establishing guidance and procedures
  - Establish and publish scientifically derived ambient criteria [CWA Section 304(a)]
    - 1968 Green
    - 1973 Blue
    - 1976 Red
    - 1980 Toxics
    - 1986 Gold
    - www.epa.gov/OST
  - Establish procedures for deriving criteria

Antidegradation Policy - 40 CFR §131.12

- Ensures that once a use is achieved it will be maintained
- Each State is required to adopt an antidegradation policy and method of implementation

EPA

Antidegradation Policy (Continued)

- Three tiers
  I. Level of quality necessary to protect existing uses
  II. Protection of actual water quality where water quality exceeds levels necessary to protect fish and wildlife propagation and recreation on and in the water
  III. Special protection of waters designated as Outstanding National Resource Waters (ONRW)

Outstanding National Resources Water (ONRW)

- Outstanding National Resources Water (ONRW)
  - National and State parks
  - Wildlife refuge
  - Ecologically unique water that need additional protection or are of special significance (i.e., swamps, hotsprings, etc.)

EPA

Tiers of Antidegradation Policy

ONRW — TIER III

TIER II ½ ??

Better than Fishable / Swimmable — TIER II
40 CFR 131.12(a)(2)

Existing Use — TIER I

Implementation of Water Quality Standards

- States must assess compliance with water quality standards for all water bodies
- If water quality standards are not being achieved, controls must be developed to achieve water quality standards
  - Point sources
  - Non-point sources

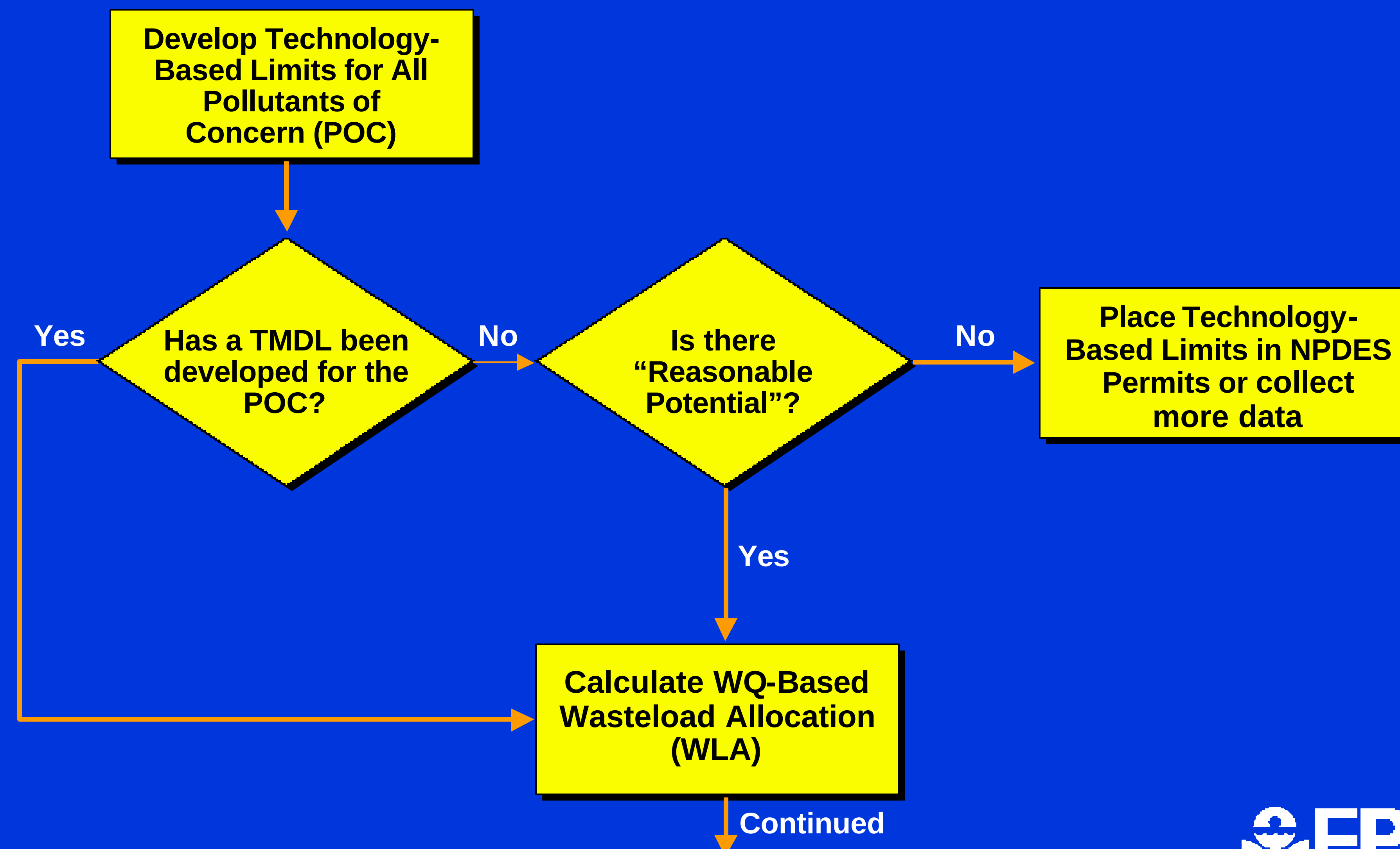
EPA

Standards to Permits Process

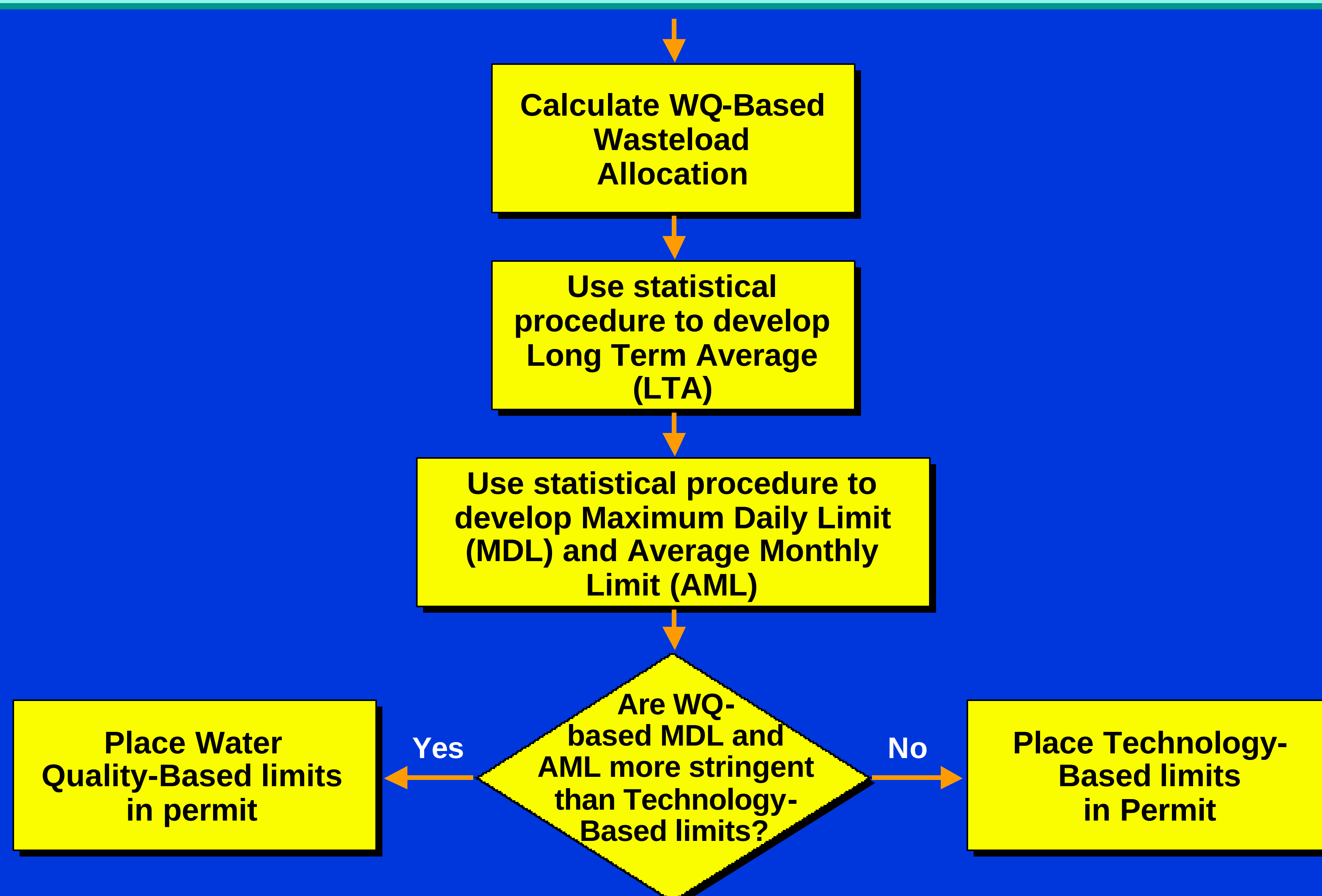
Learning Objectives

- Introduce Total Maximum Daily Loads (TMDL)
- Explain concept of Wasteload Allocation (WLA)
- Summarize statistical approach to developing water quality-based effluent limitations

Standards-to-Permits Process



Standards-to-Permits Process
(Continued)



Total Maximum Daily Load (TMDL)

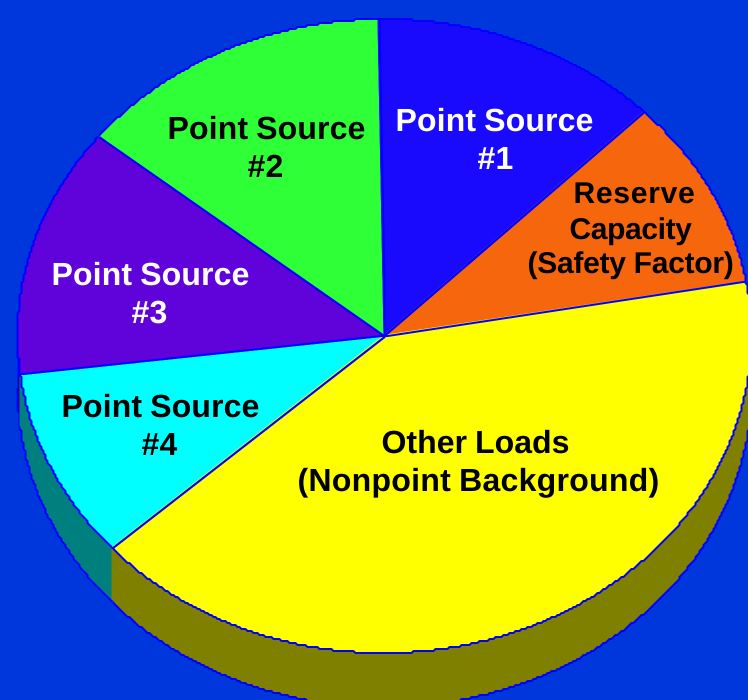
- **CWA Section 303(d)(1)**
  - Requires States to identify waters that will not achieve water quality standards after implementation of technology-based limits
  - States rank identified waters based on severity of pollution and uses
  - Requires TMDL for priority waters

Total Maximum Daily Load (TMDL)
(Continued)

- **Used as a tool for implementing water quality standards**
- **Defined as the amount of a pollutant that may be discharged into a waterbody and still meet water quality standard**

EPA

Components of TMDL



- Wasteload allocations (WLAs) are assigned to each point source discharge
- Load allocations (LAs) are assigned to nonpoint sources
- WLAs and LAs are established so that predicted receiving water concentrations do not exceed water quality criteria

Use of Water Quality-Based Effluent Limitations

- **Water quality-based limitations are used when it has been determined that more <u>stringent</u> limits than technology-based effluent limits must be applied to a discharge in order to protect "designated use" of the receiving waters.
(40 CFR §122.44(d)(1))**

EPA

Reasonable Potential
40 CFR §122.44(d)(1)(i)

- Limitations must be established in permits to control all pollutants or pollutant parameters that are or may be discharged at a level which will cause, have reasonable potential to cause, or contribute to an excursion above any state water quality standard.

EPA

Reasonable Potential Decision Criteria

- Cause
- Reasonable Potential to Cause
- Contribute

Reasonable Potential Analysis Without Effluent Data

- Effluent Variability
  - Compliance history
  - History of toxic impacts
- Point/nonpoint source controls
  - Existing treatment technology
  - Type of industry or POTW
  - Best Management Practices (BMPs)

Reasonable Potential Analysis Without Effluent Data (Continued)

- Species Sensitivity
  - In-stream data
  - Adopted water quality criteria and designated uses
- Dilution
  - Critical receiving water flow
  - Mixing zones

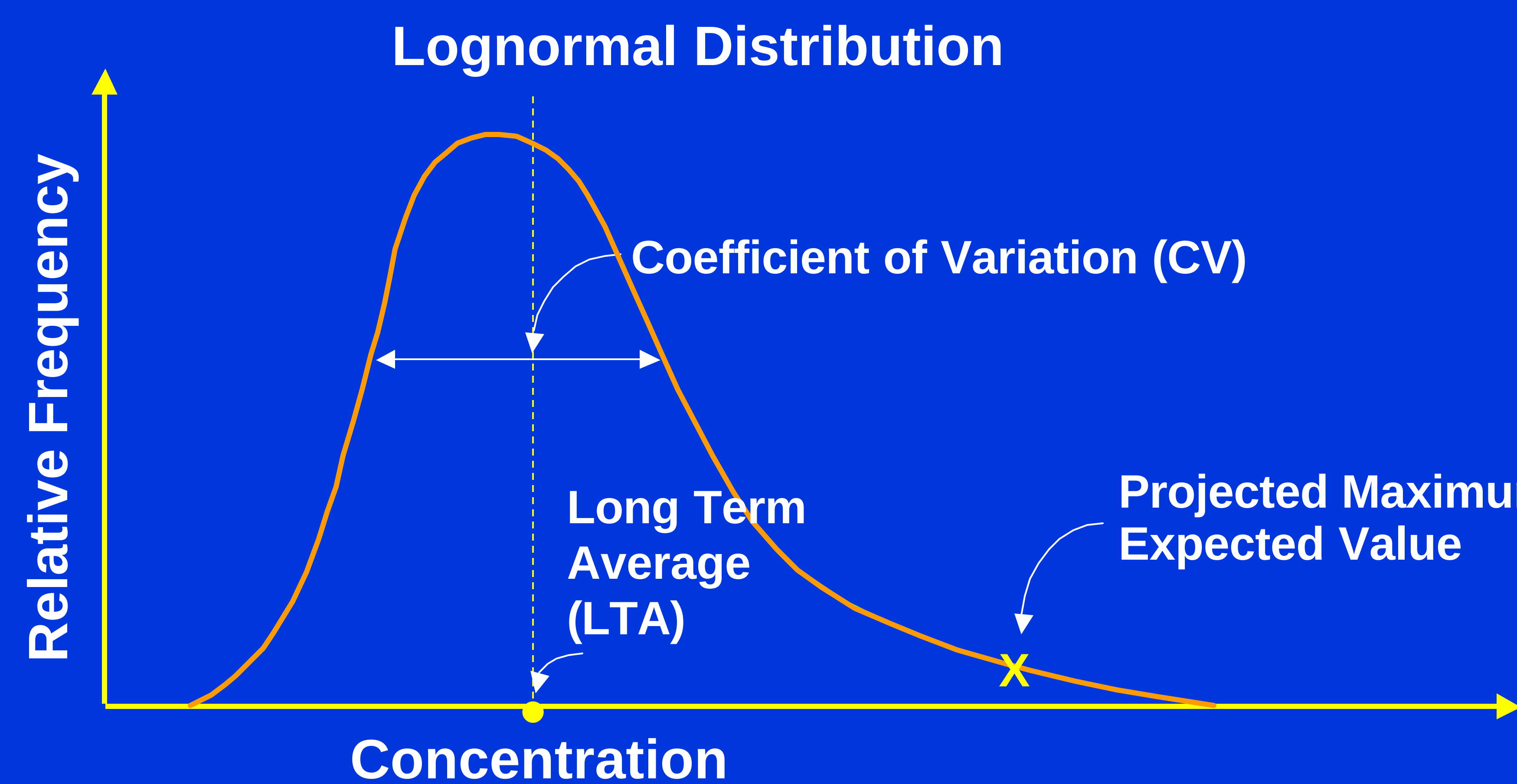
EPA

Reasonable Potential Analysis With Effluent Monitoring Data

- **Must consider uncertainty associated with sparse data sets and effluent variability**

EPA

Reasonable Potential Analysis with Effluent Data



Reasonable Potential Analysis

Projected Maximum Effluent Concentration → Water Quality Model → Projected Receiving Water Concentration (Cr)

Determining the Need

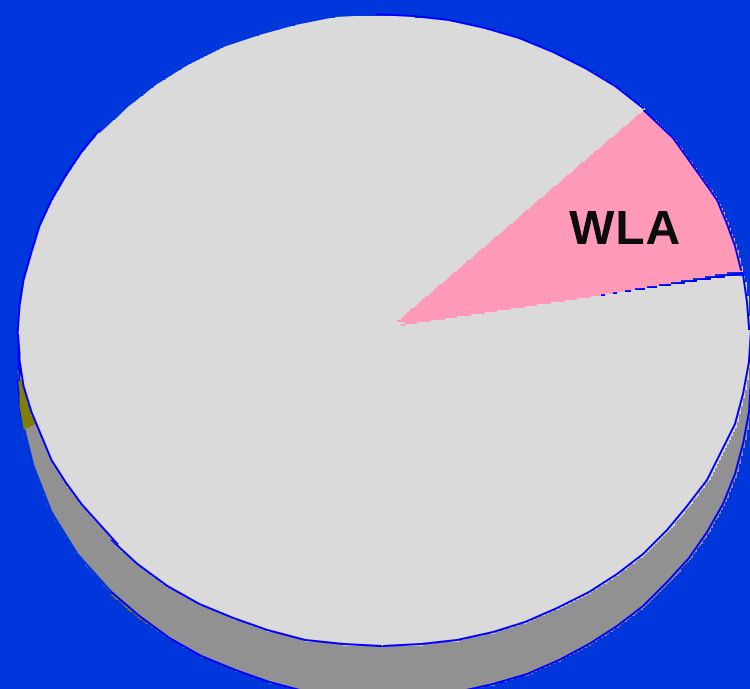
- If Cr > State WQ criterion, then <u>need</u> to establish a WQ-based limit.
- If Cr $\leq$ State WQ criterion, then <u>no</u> need to establish a WQ-based limit.

Determining the Need for Water Quality-Based Effluent Limits

Criteria	Type of Limit	Regulatory Cite
Chemical-specific	Chemical specific	40 CFR §122.44(d)(1)(iii)
WET numeric	WET	40 CFR §122.44(d)(1)(iv)
Narrative	WET or Chemical specific	40 CFR §122.44(d)(1)(v-vi)

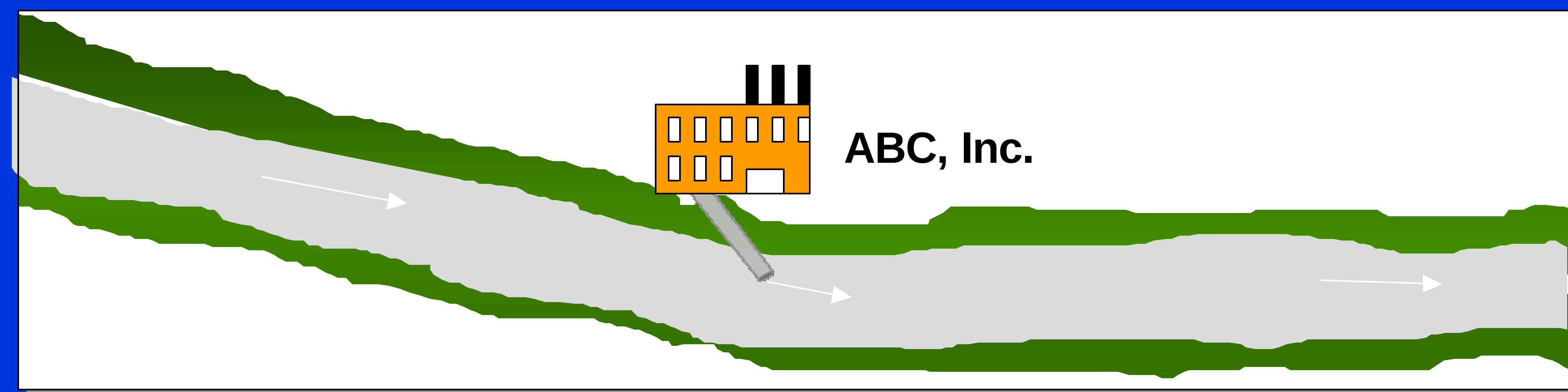
EPA

TMDL-Based Wasteload Allocation



WLA = portion of the receiving water's total maximum daily load (TMDL) that is allocated to a specific point source

Facility-Specific Wasteload Allocation

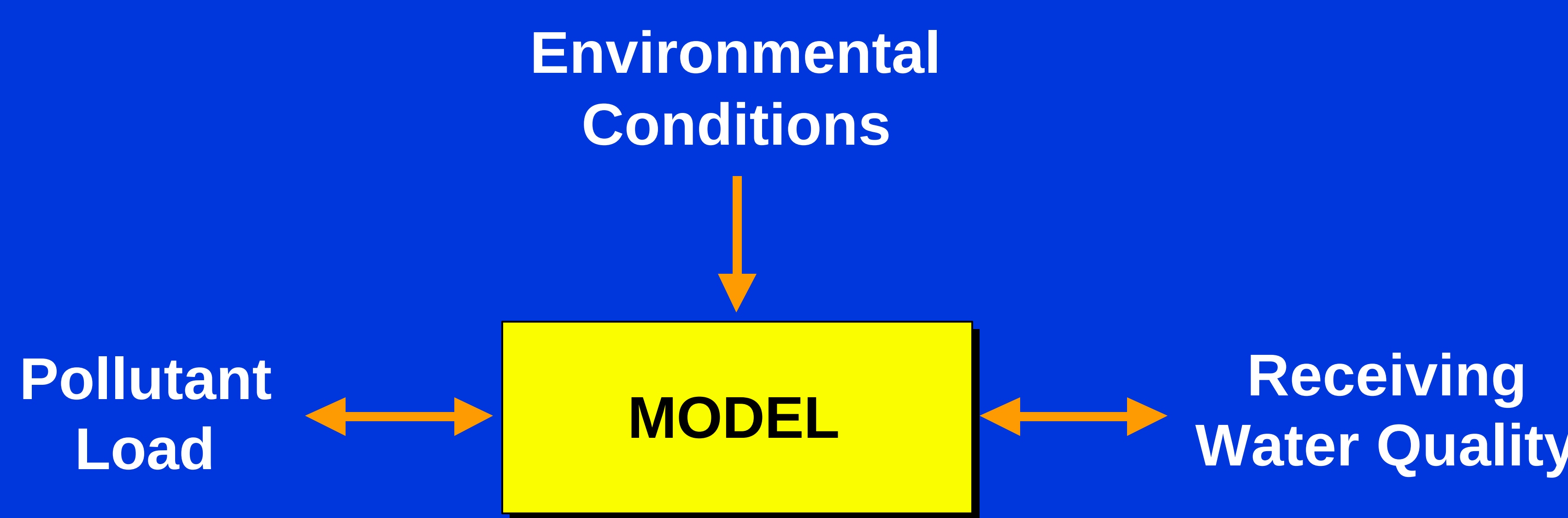


WLA = the maximum allowable pollutant concentration in the effluent from ABC, Inc. which, after accounting for available dilution, will meet water quality standards in-stream

EPA

Developing Wasteload Allocations

Models can help determine pollutant loadings that will not violate water quality criteria.

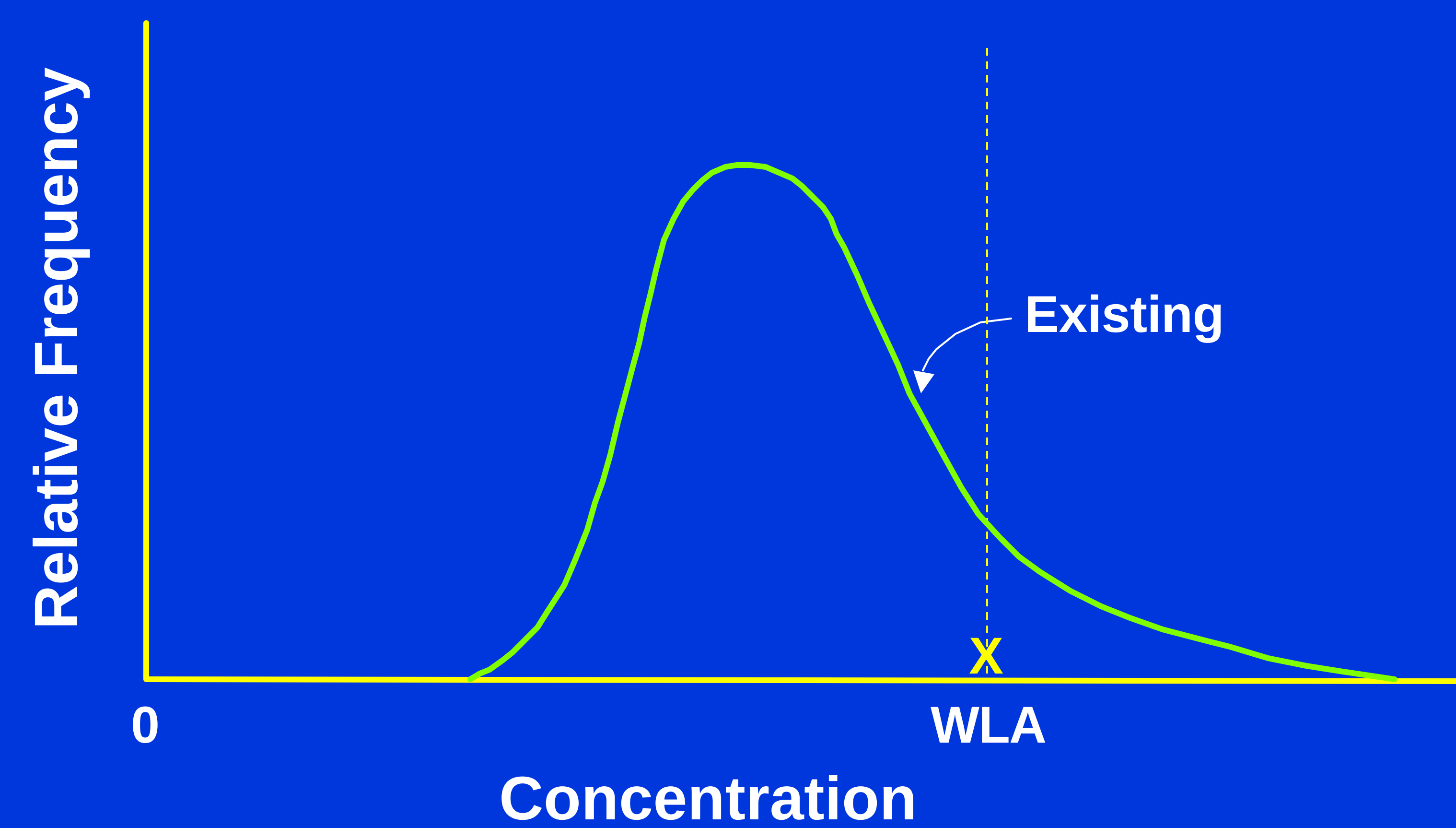


Maximum Daily and Average Monthly Limits

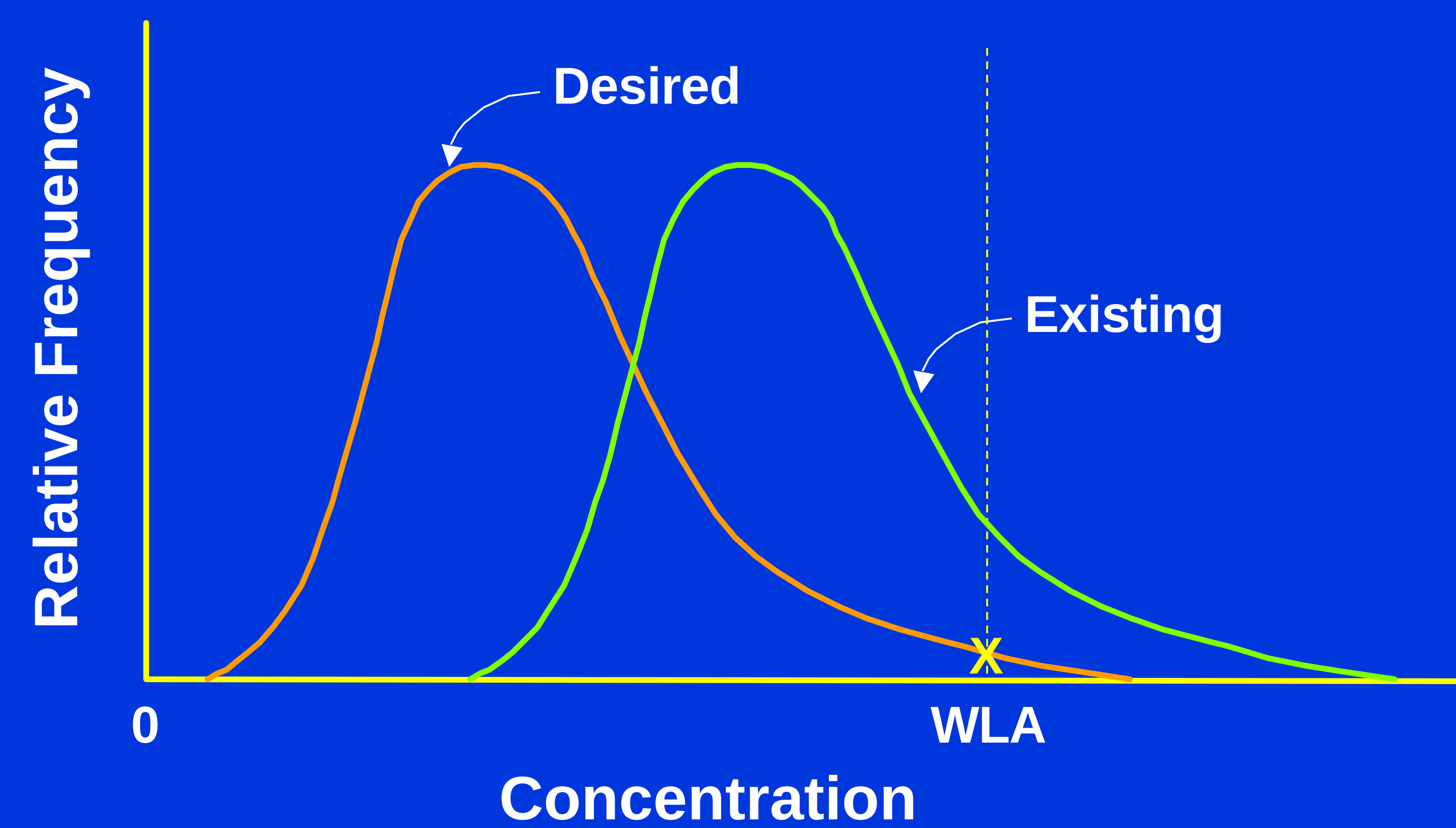
- 40 CFR §122.45(d) requires all permit limits (unless impracticable) be expressed as:
  - Average weekly and average monthly limits for POTWs (EPA recommends a maximum daily limit rather than an average weekly limit for water quality-based permitting for toxics)
  - Maximum daily and average monthly limits for other dischargers
    - How do we use the wasteload allocation to develop water quality-based effluent limits?

EPA

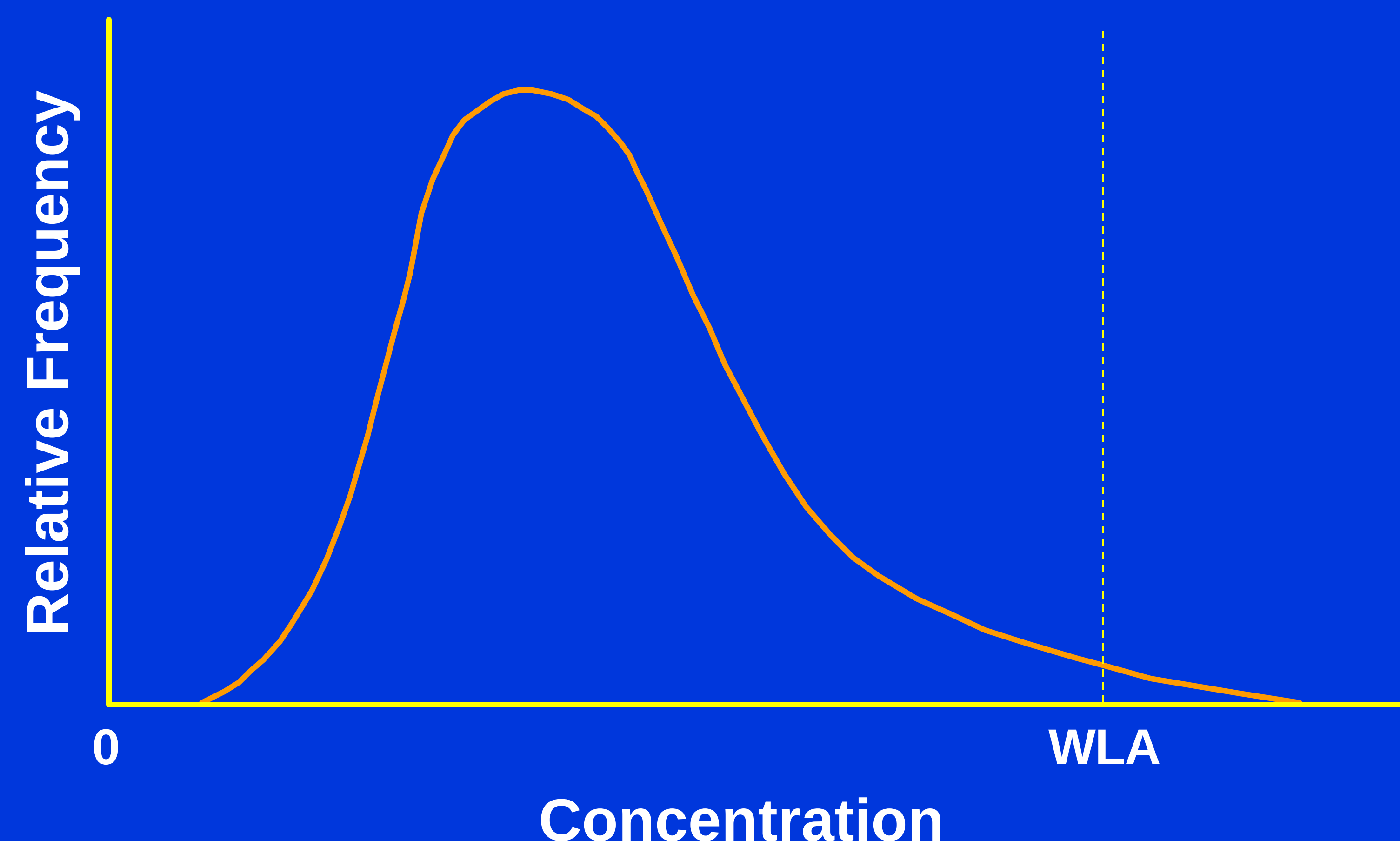
Goal is to Reduce Effluent Concentrations to Below the WLA



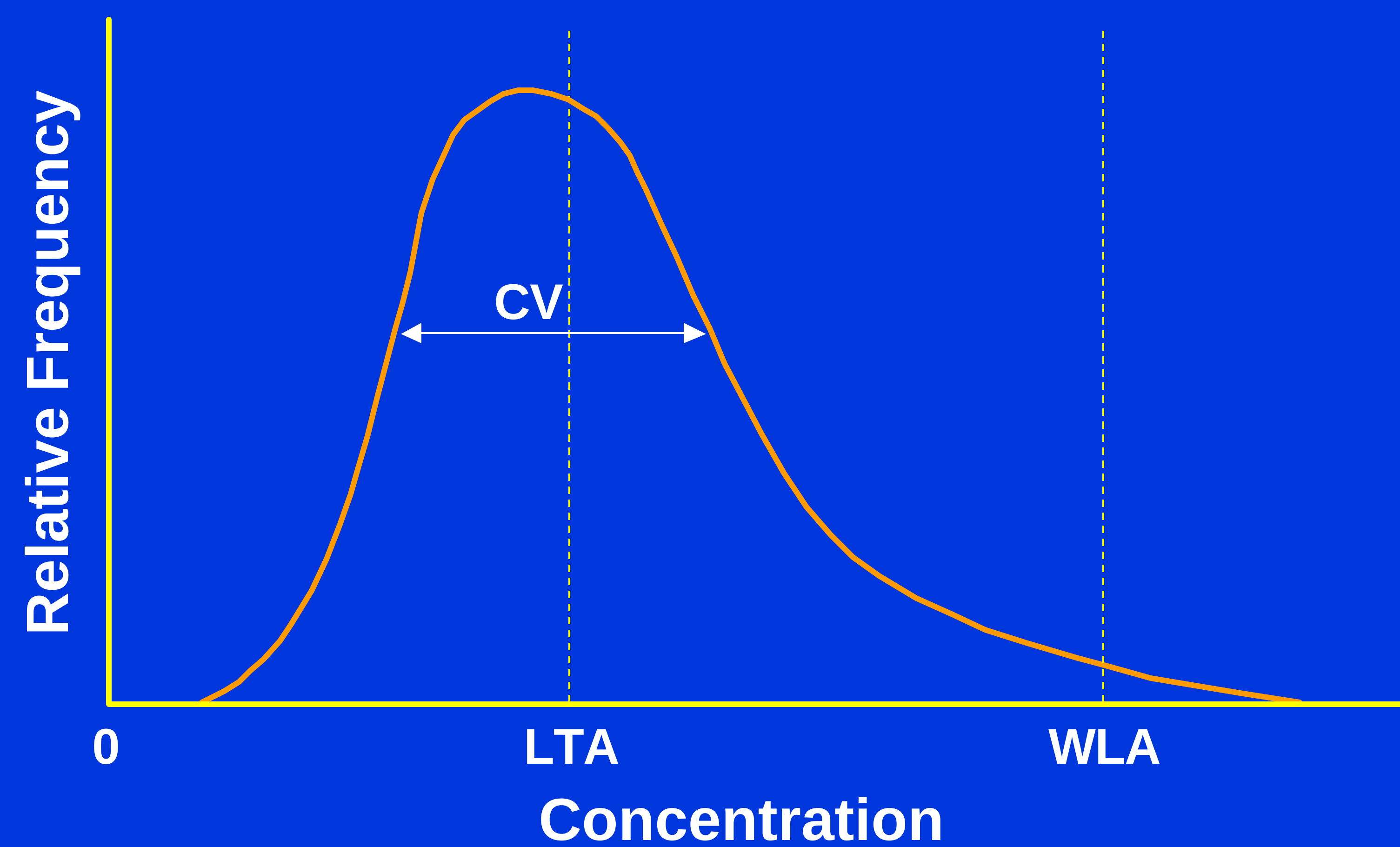
Goal is to Reduce Effluent Concentrations to Below the WLA



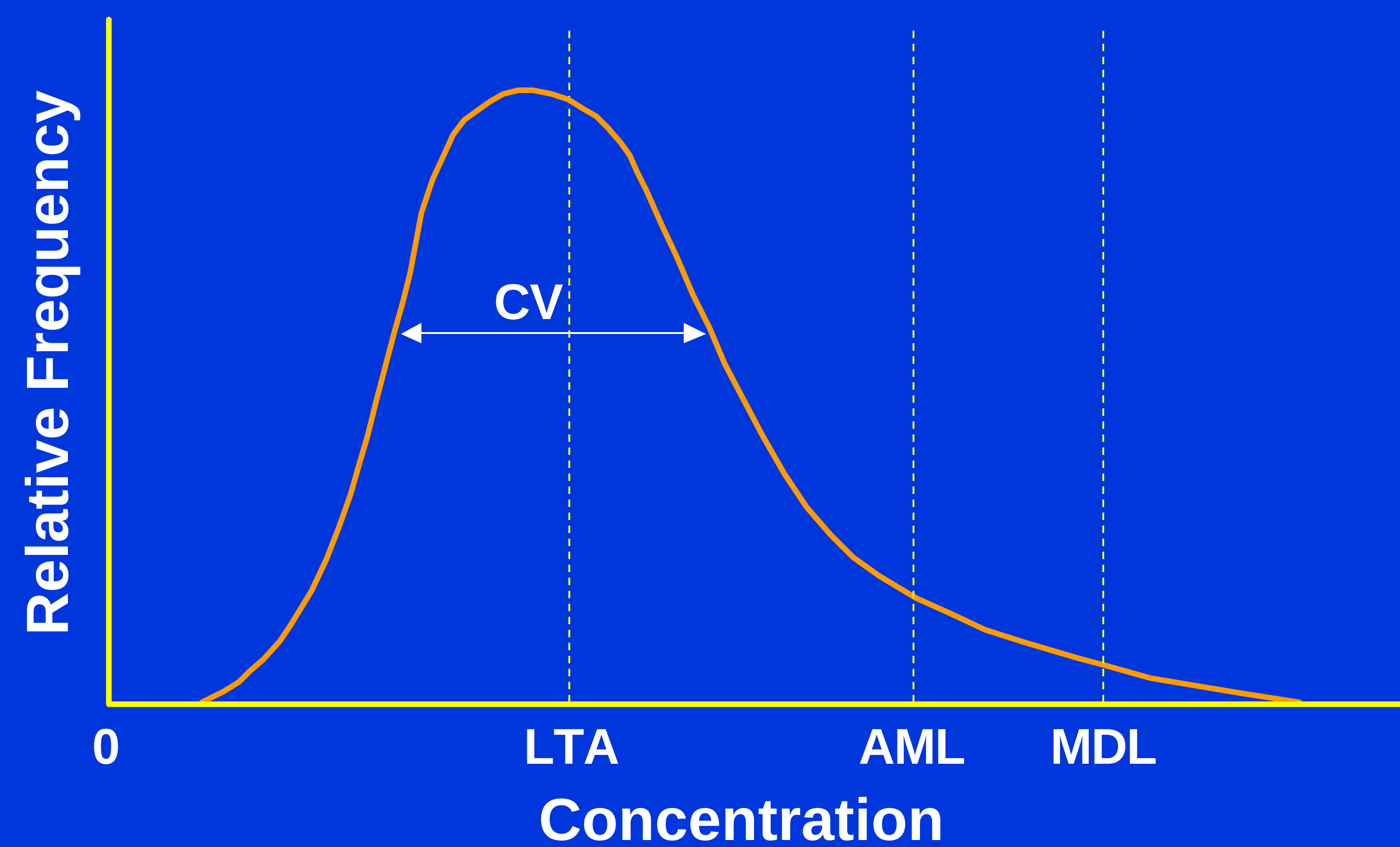
This Distribution Achieves the Goal



We Can Characterize the Desired Distribution by LTA and CV



We Can Determine the Effluent Limits Based Upon the Distribution



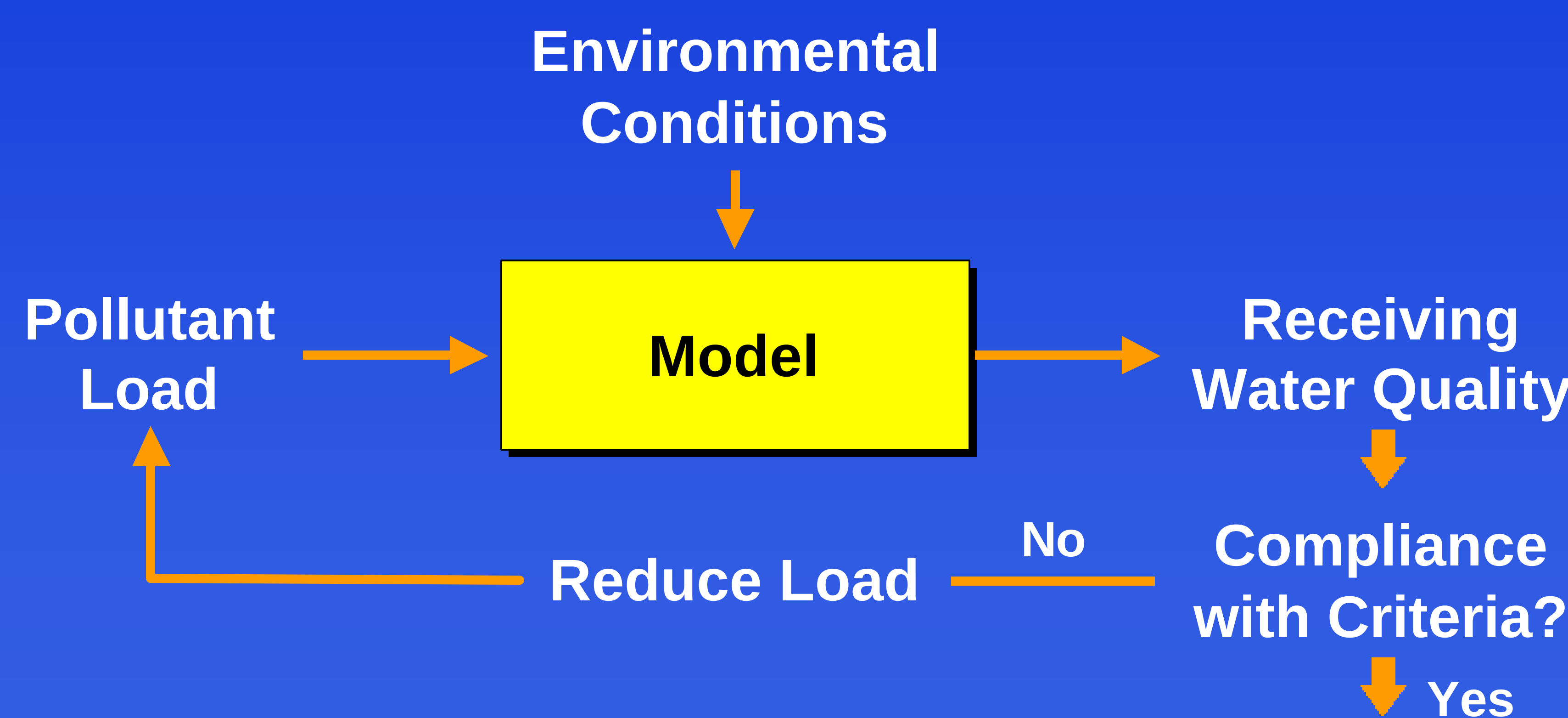
Introduction to Mixing and Modeling

Learning Objectives

- Introduce modeling principles
- Explain concept of “mixing zone”
- Define steady state and dynamic models

Why Use Models?

- Models can help determine pollutant loadings that will not violate water quality criteria



Decision Tree for Model Selection

Do water quality standards allow consideration of dilution?

No

Yes

No model necessary

Determine level of dilution allowed by water quality standards

Allowable Dilution

- Clean Water Act does not require attaining water quality criteria at the point of discharge
- States have discretion to allow dilution
- States should specify any conditions on dilution allowances as part of their water quality standards

Allowable Dilution

Water Quality Standards often allow dilution …

- **up to 100% of critical flow(e.g., 7Q10 low flow) if there is *rapid and complete mixing***
- **within a limited mixing zone at the critical flow if there is *incomplete mixing***

Decision Tree for Model Selection
(Continued)

Is there rapid and complete mixing?

Yes → Complete mix assessment

No → Incomplete mix assessment

Complete mix assessment → Are resources available for dynamic modeling and is a dynamic model desirable?

- No → Steady state model
- Yes → Dynamic model

Incomplete mix assessment → Are resources available for dynamic modeling and is a dynamic model desirable?

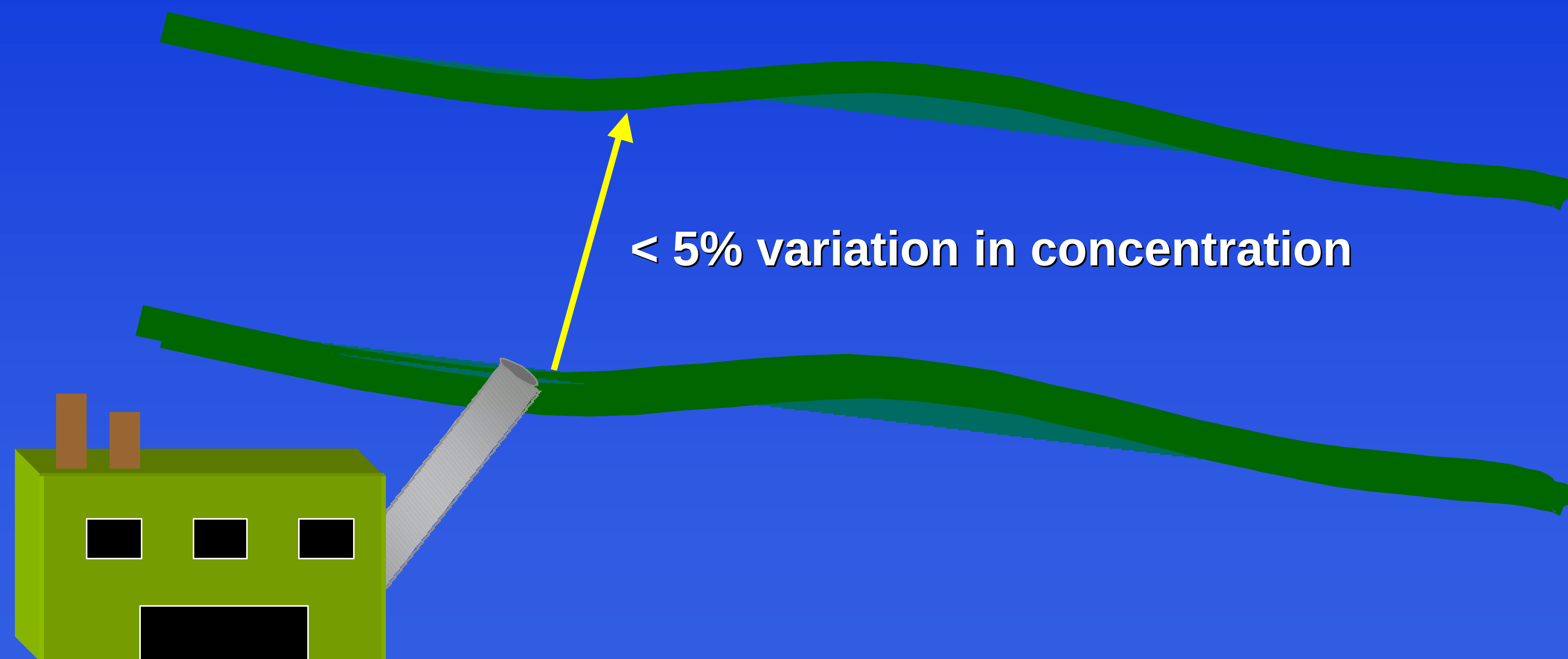
- No → Steady state model
- Yes → Dynamic model

What is Rapid and Complete Mixing?

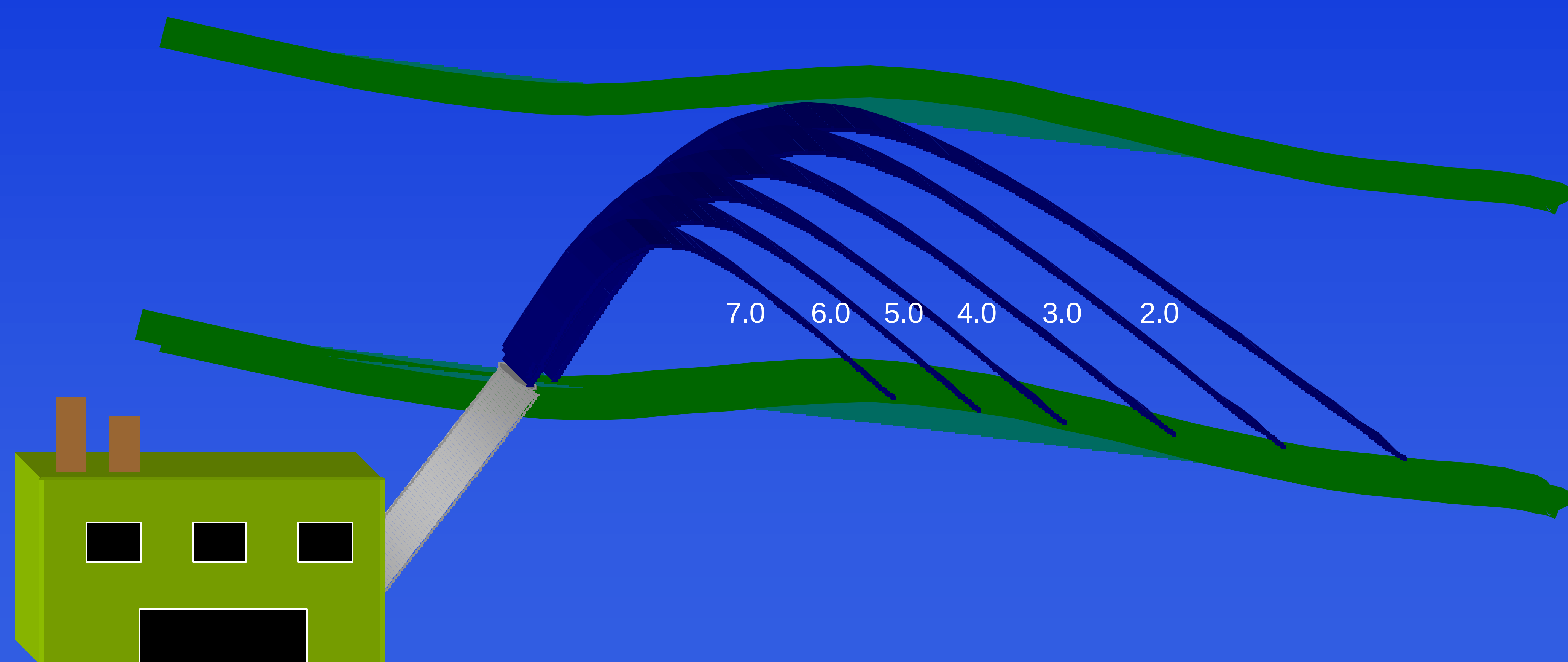
- Rapid and complete mixing occurs when lateral variation in concentration in the direct vicinity of the outfall is small (e.g., less than 5%)
- Potential occurrences include:
  - Effluent dominated systems (effluent flow greater than stream flow)
  - Diffuser located across entire stream width

EPA

Rapid and Complete Mixing



Incomplete Mixing



Examples of Allowable Dilution in Rapid and Complete Mix Situations

- 100% of 1Q10 low flow
- 50% of 7Q10 low flow
- 25% of 7Q2 low flow or 1 cfs, whichever is greater

Incomplete Mix Assessment

- Field Studies
  - Actual measurement of instream contaminant concentrations
  - Dye studies
- Modeling
  - Calibrated to actual observations
  - Simulate critical conditions

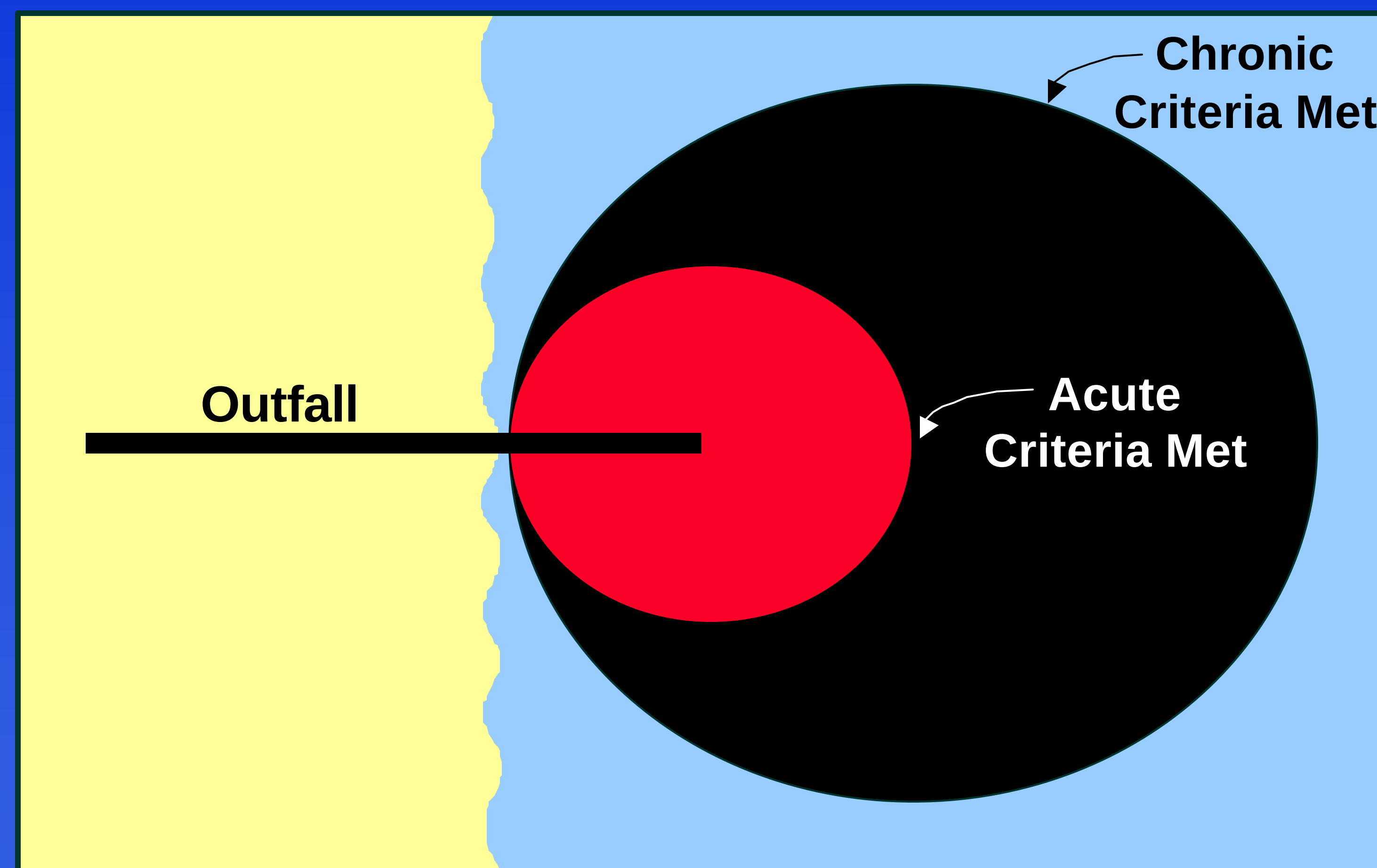
EPA

Regulatory Mixing Zones

- **Definition**
  - A limited area or volume of water where initial dilution of a discharge takes place and where water quality criteria can be exceeded
- **Constraints**
  - Cannot impair integrity of the waterbody
  - No significant health risks
  - No lethality to passing organisms

EPA

Regulatory Mixing Zones (Continued)



Examples of Regulatory Mixing Zones

- < 1/4 of stream width and 1/4 mile downstream
- <1/2 stream width and longitudinal limit of 5 X stream width
- Default dilution of no more than 10% of critical flow
- No more than 5% of the lake surface
- Default of no more than 4:1 dilution for lake discharges

EPA

Steady State Model

- Predicts the magnitude of pollutant concentration for a single set of environmental conditions
- Used when complete data are not available

Steady State Model (Continued)

- Assume "critical conditions" for flow, pollutant concentrations and environmental effects
- Choose conditions that reflect the duration and frequency concerns for the applicable criteria

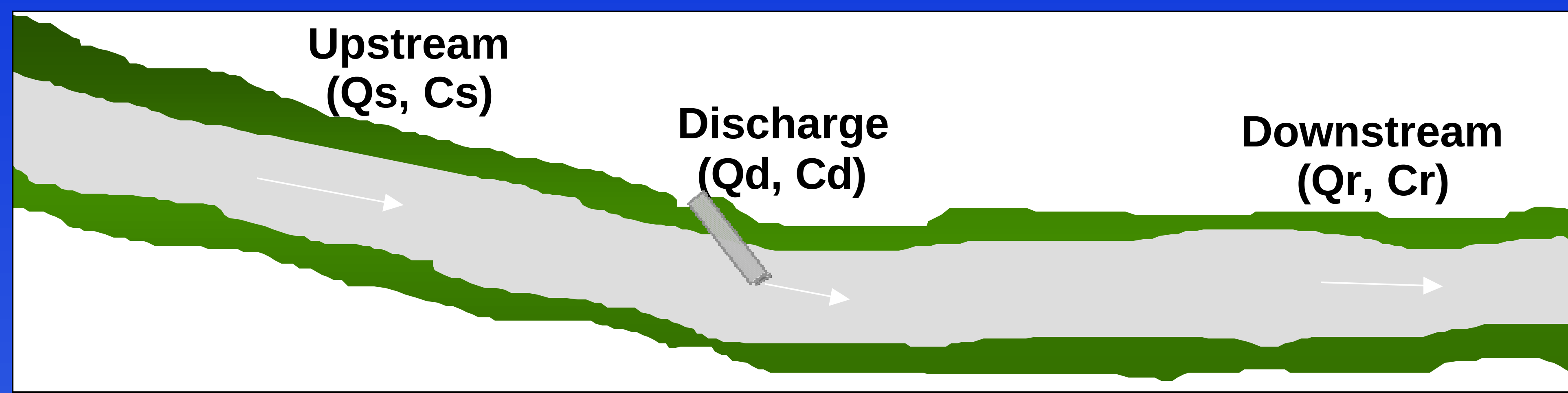
Steady State Model (Continued)

Example Critical Condition:

Dilution Flow

Acute Toxicity:	1Q10 low flow
Chronic Toxicity:	7Q10 low flow
Human Health:	Harmonic mean flow, 30Q5 low flow

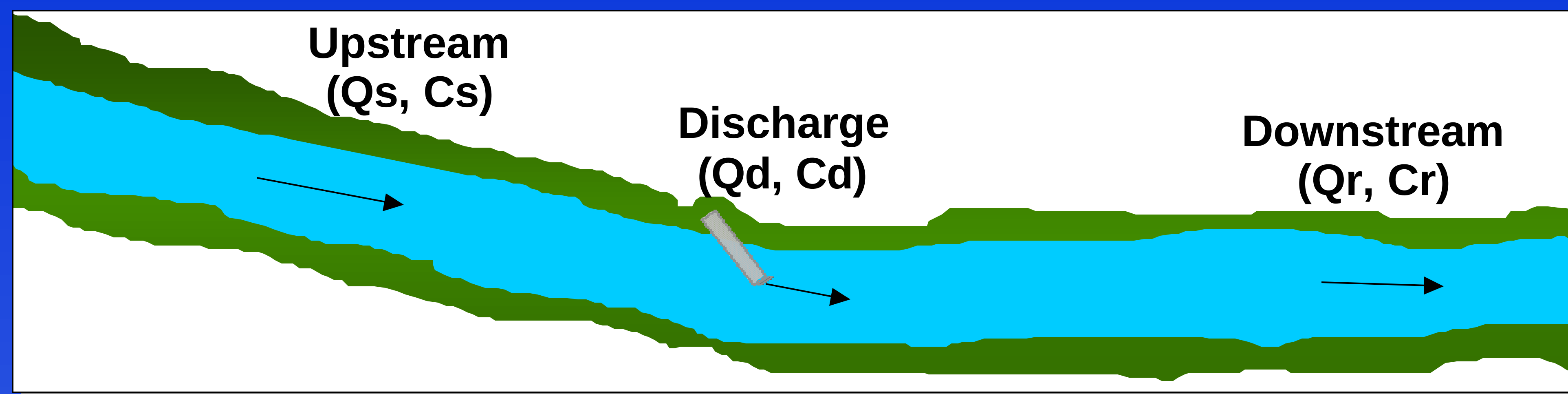
Steady State Complete Mix Assessment



Mass-Balance Equation: QdCd + QsCs = QrCr

- Q = Flow (mgd or cfs)
- C = Pollutant concentration (mg/l)
- Mass = [Concentration] [Flow]

Mass-Balance Equation
$QdCd + QsCs = QrCr$



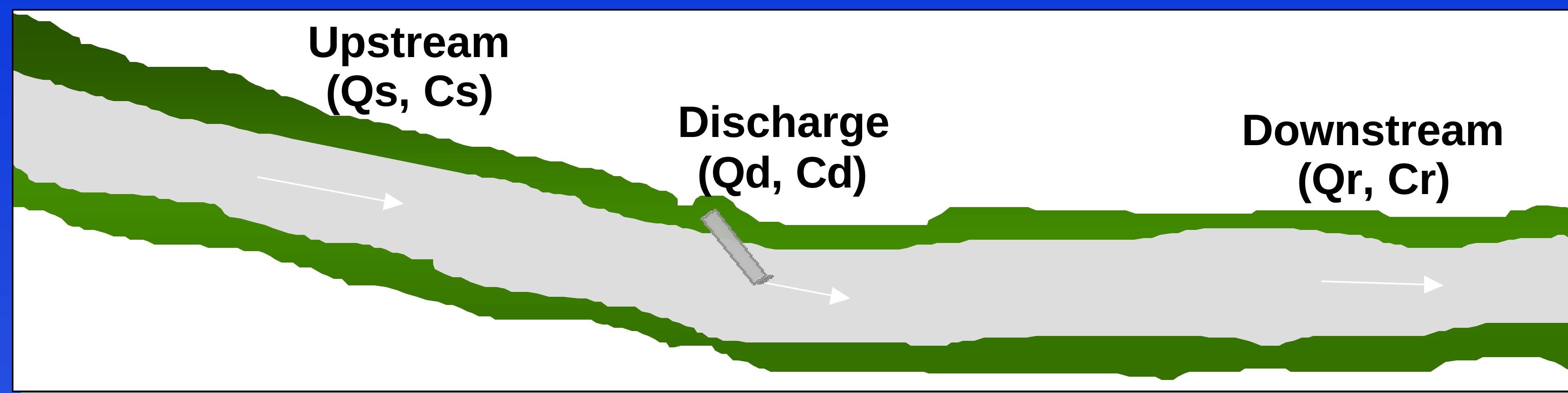
$$Cr = \frac{QdCd + QsCs}{Qr}$$

Cr = applicable water quality criterion

Qs = receiving water flow available for dilution as specified in water quality standards (e.g., 100% of 7Q10 low flow for rapid and complete mixing)

EPA

Mass-Balance Equation
QdCd + QsCs = QrCr



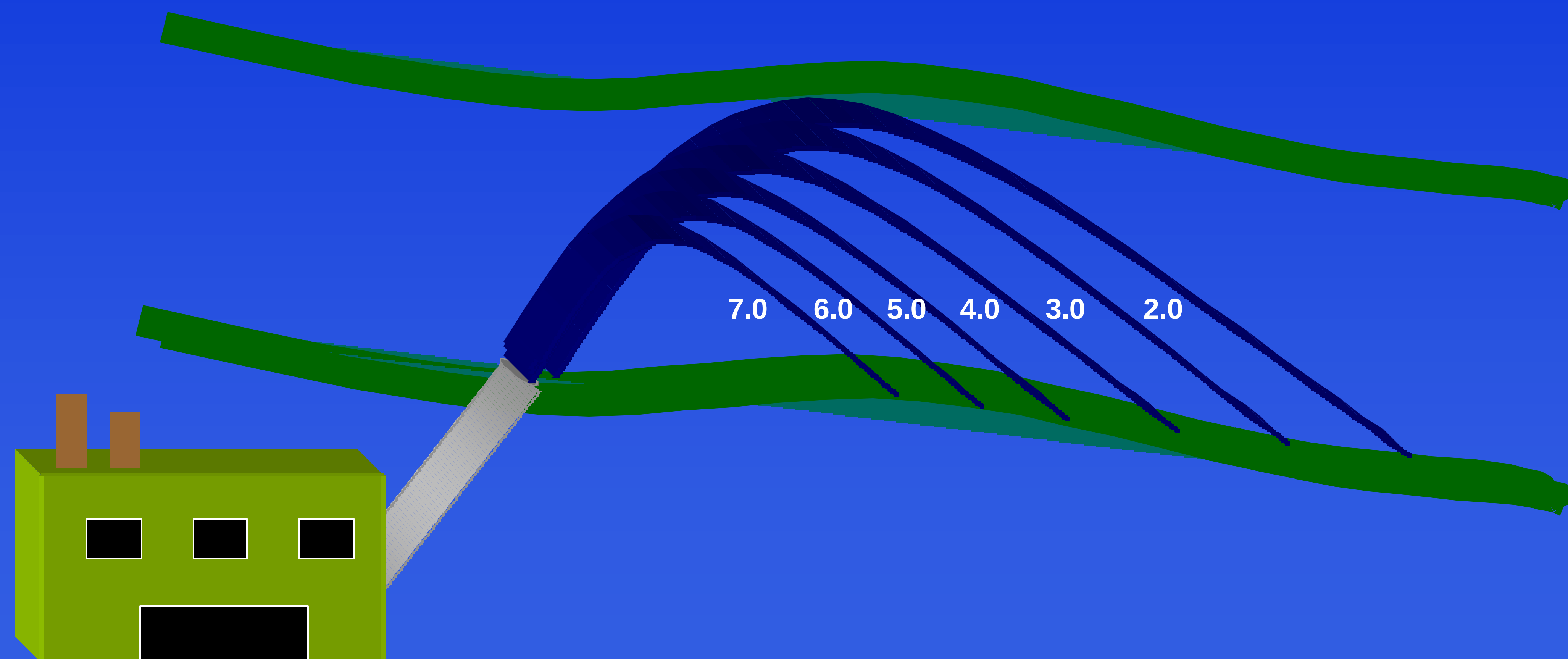
$$Cd = \frac{QrCr - QsCs}{Qd}$$

Cr = applicable water quality criterion

Qs = receiving water flow available for dilution as specified in water quality standards (e.g., 100% of 7Q10 low flow for rapid and complete mixing)

Steady-State
Incomplete Mix Assessment

What if the applicable water quality criterion = 4.0 µg/l?



Decision Tree for Model Selection
(Continued)

Is there rapid and complete mixing?

Yes → Complete mix assessment

No → Incomplete mix assessment

Complete mix assessment

Are resources available for dynamic modeling and is a dynamic model desirable?

No → Steady state model

Yes → Dynamic model

Incomplete mix assessment

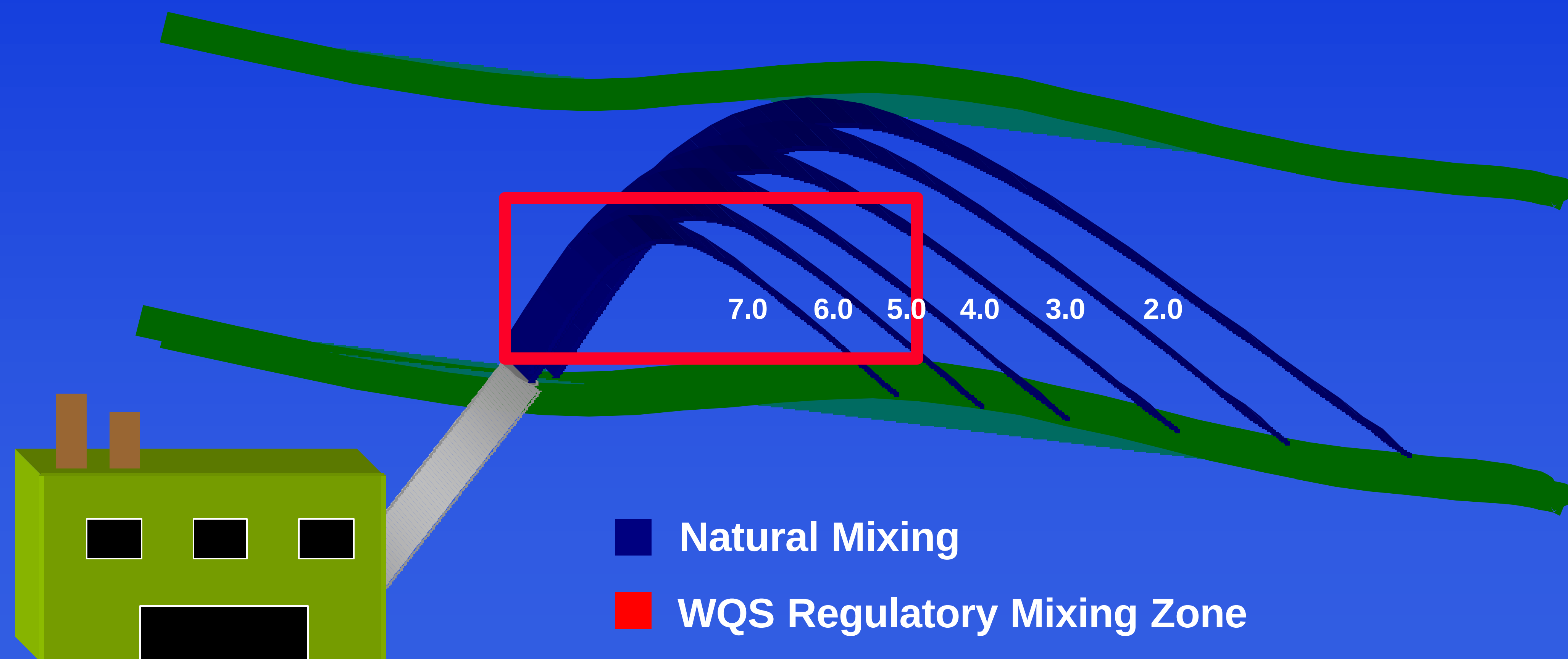
Are resources available for dynamic modeling and is a dynamic model desirable?

No → Steady state model

Yes → Dynamic model

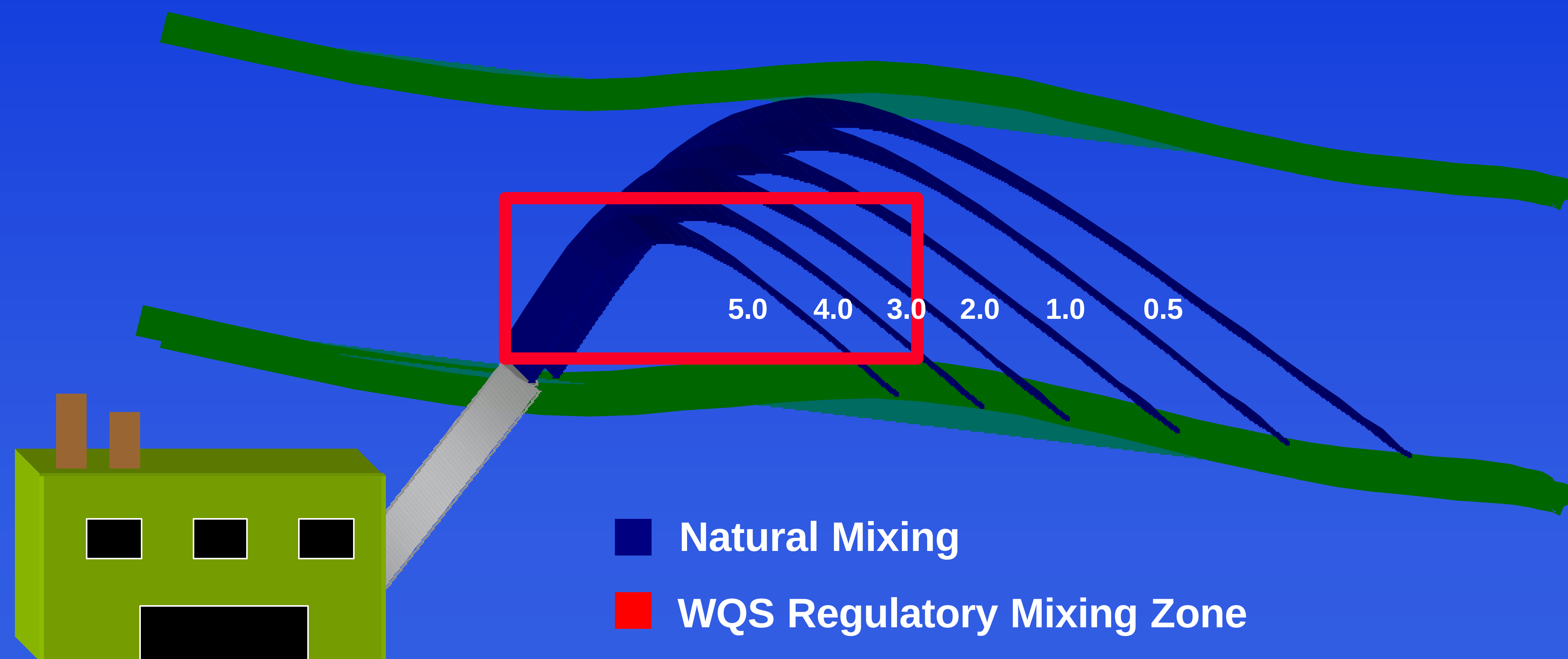
Steady-State
Incomplete Mix Assessment

What if the applicable water quality criterion = 4.0 µg/l?



Steady-State
Incomplete Mix Assessment

What if the applicable water quality criterion = 4.0 µg/l?



Dynamic Model

- Used when adequate data are available to estimate frequency distribution of effluent quality
- Accounts for daily variations of and relationships between effluent, receiving water, and environmental conditions

EPA

Dynamic Model (Continued)

- Variability in model inputs
- Results are expressed as a probability of exceeding criteria instead of a single value
  - Continuous simulation
  - Monte Carlo simulation
  - Log-normal analysis

EPA

Considerations in Water Quality Modeling

- Applicable water quality standards and implementation procedures
  - Criteria and designated uses
  - Critical receiving water flows or volumes
  - Allowable dilution
- Discharge characteristics
  - Flow rate
  - Pollutant concentrations

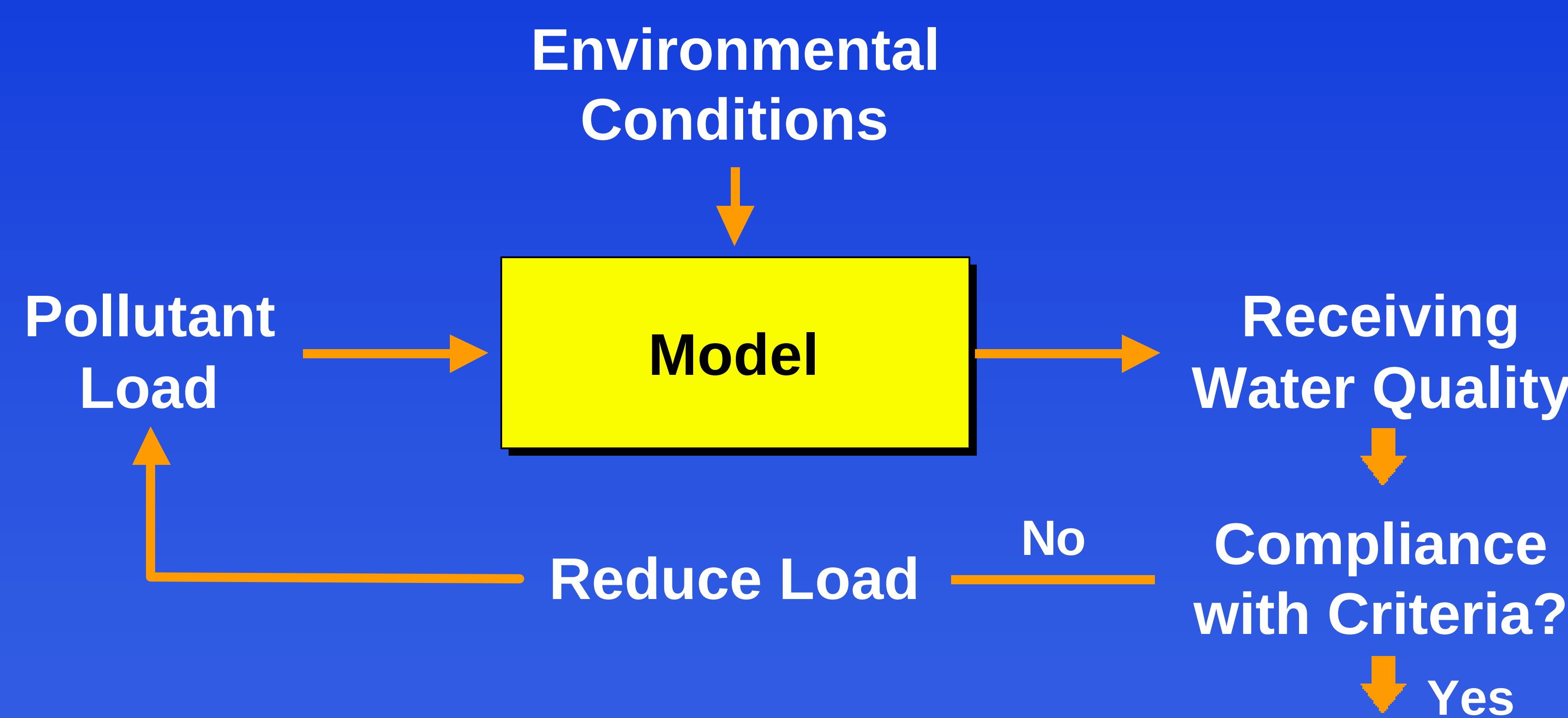
EPA

Considerations in Water Quality Modeling
(Continued)

- Receiving water characteristics
  - Pollutant concentrations (i.e., background)
  - Stream flow
- Pollutant characteristics
  - Type of pollutant
    - Non-conservative: mitigated by natural stream dilution and degradation in the receiving stream (e.g., ammonia, bacteria)
    - Conservative: mitigated by natural stream dilution (e.g., heavy metals)
  - Reaction rates

EPA

Why Use Models?

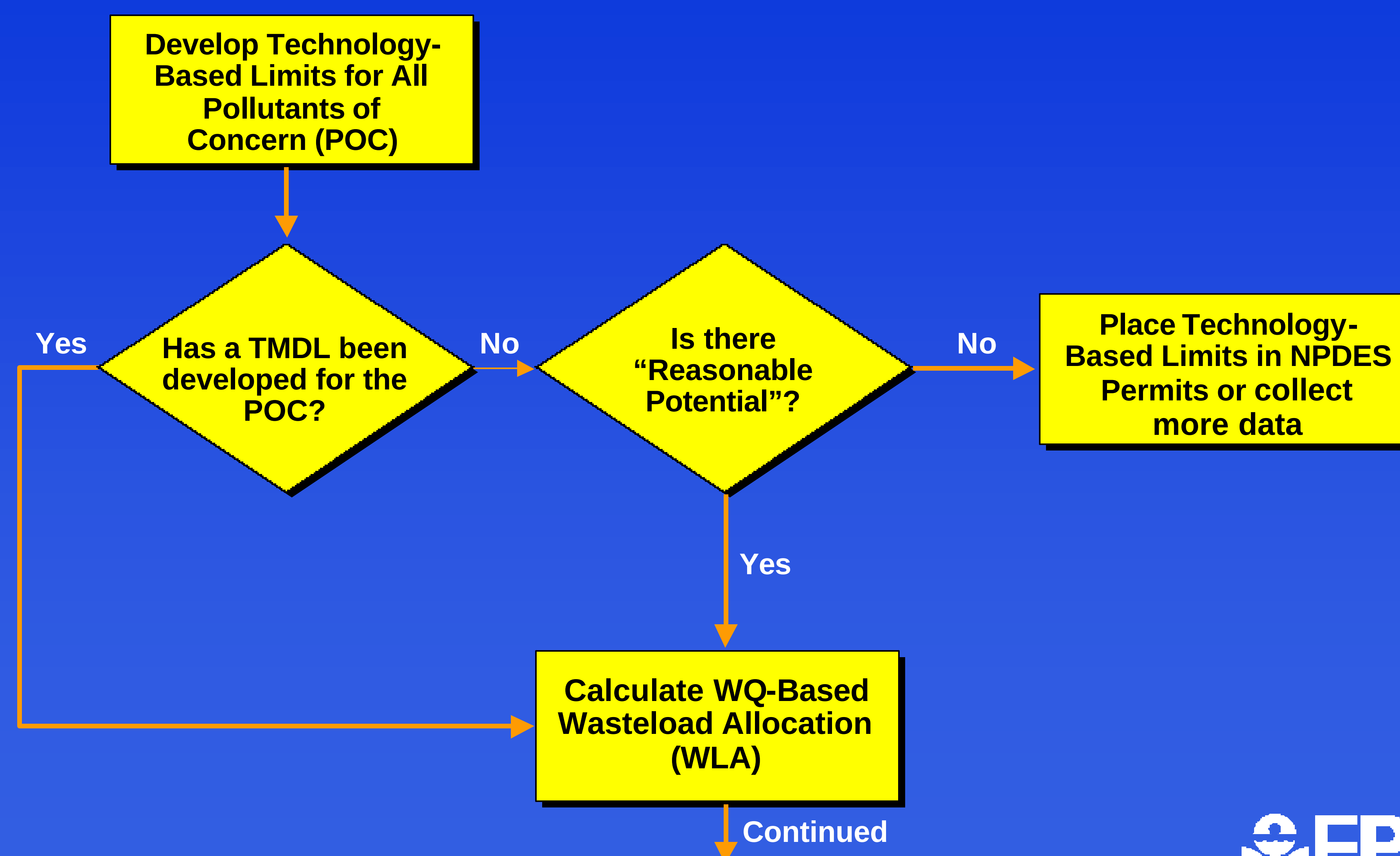


Developing Chemical-Specific Water Quality-Based Effluent Limits

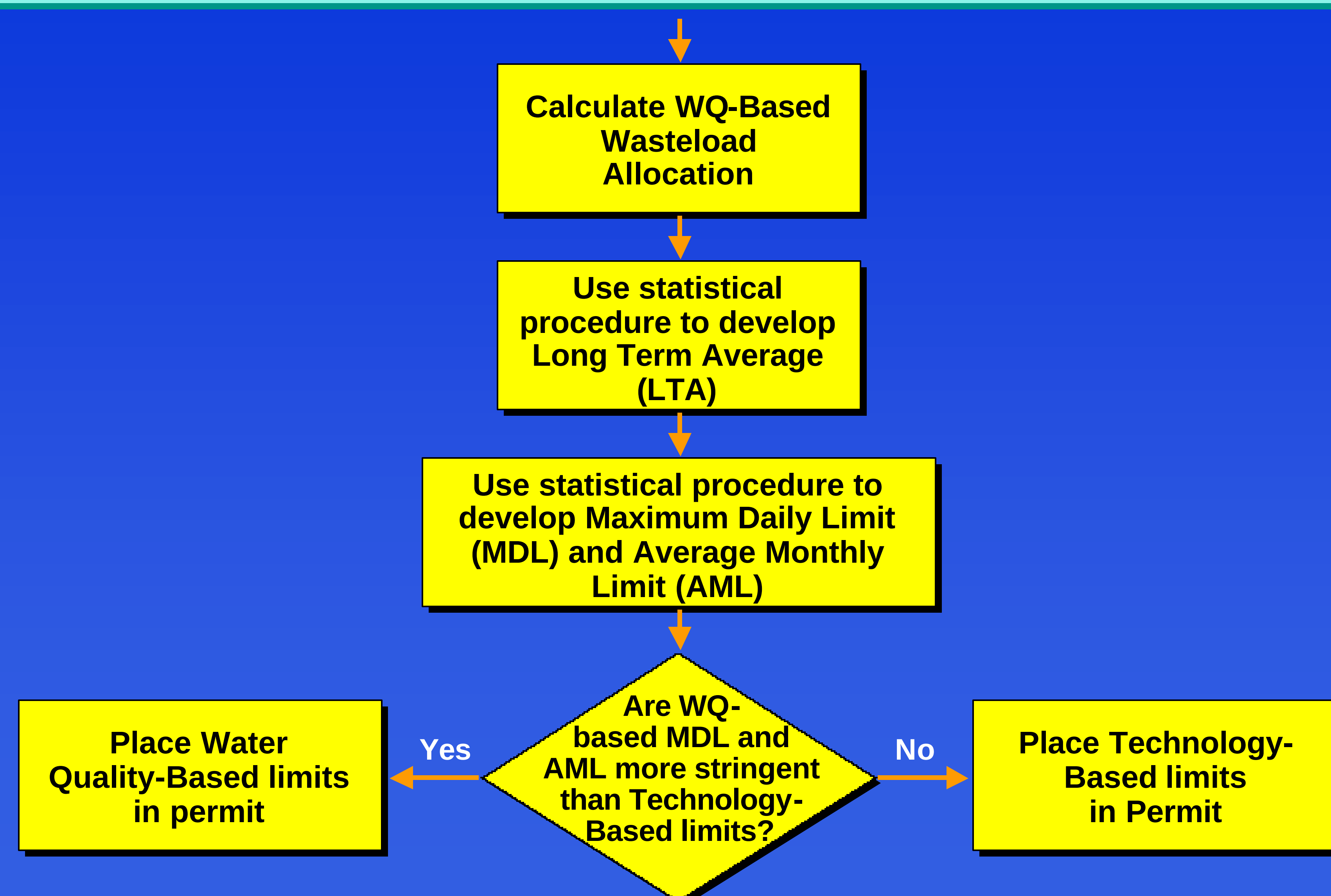
Learning Objectives

- Review process for determining "reasonable potential"
- Discuss procedures for calculating wasteload allocations
- Explain steps for translating a wasteload allocation into water quality-based effluent limits

Standards-to-Permits Process



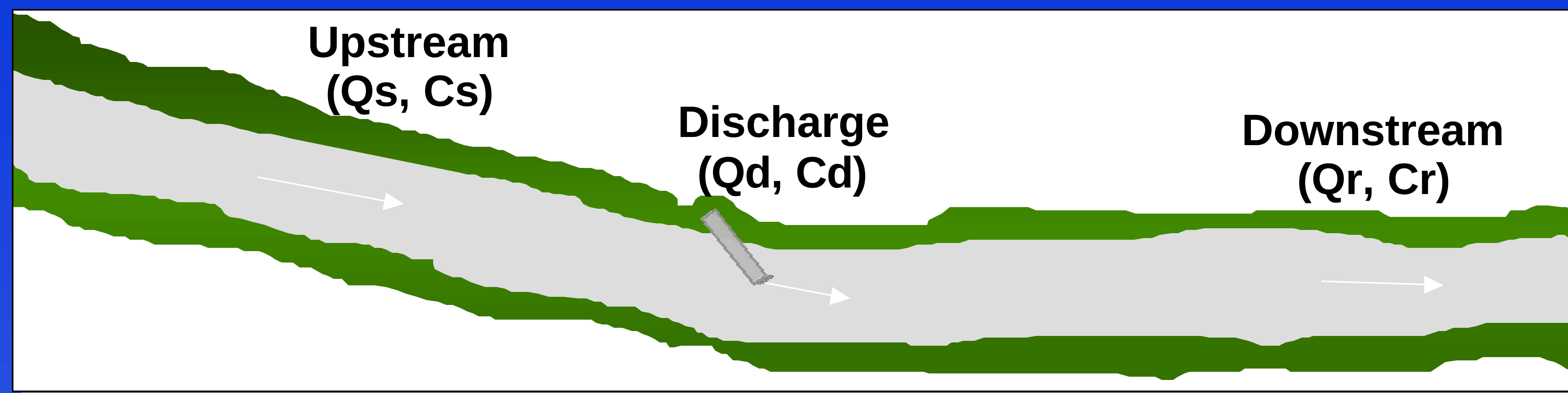
Standards-to-Permits Process
(Continued)



Determining the Need for Water Quality-Based Effluent Limits

Criteria	Type of Limit	Regulatory Cite
Chemical-specific	Chemical-specific	40 CFR §122.44(d)(1)(iii)
WET numeric	WET	40 CFR §122.44(d)(1)(iv)
Narrative	WET or Chemical specific	40 CFR §122.44(d)(1)(v-vi)

Mass-Balance Equation
$QdCd + QsCs = QrCr$

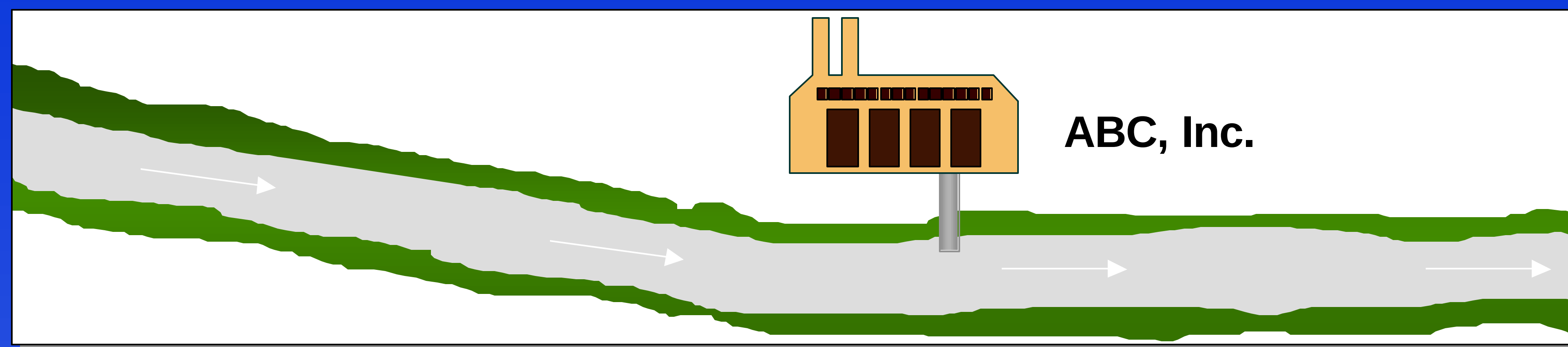


- Q = Flow (mgd or cfs)
- C = Pollutant concentration (mg/l)
- Mass = [Concentration] [Flow]
- $QdCd + QsCs = QrCr$
- To determine pollutant concentration in the stream:

$$Cr = \frac{QdCd + QsCs}{Qr}$$

Note: $Qr = Qs + Qd$

Is There Reasonable Potential to Exceed Water Quality Standards?



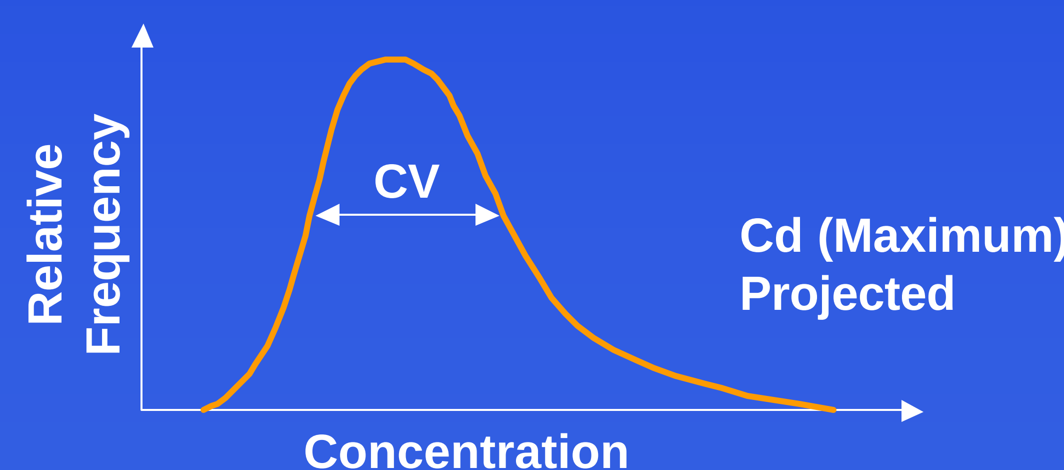
Qs	= Upstream river flow (1Q10)	= 1.2 cfs
Qd	= Discharge flow	= 0.31 cfs
Cs	= Upstream river concentration	= 0.8 mg/l
Cd	= Discharge concentration	= 1.5 mg/l
Water Quality Standard (acute criterion)		= 1.0 mg/l

$$Cr = \frac{QdCd + Qs\,Cs}{Qr} = \frac{(0.31)(1.5) + (1.2)(0.8)}{1.2 + 0.31}$$

$$Cr = 0.94 \text{ mg/l}$$

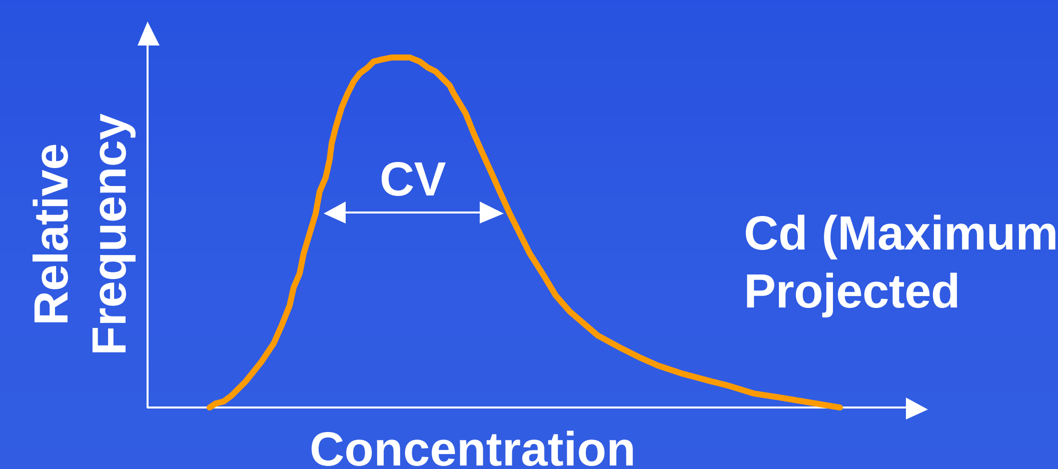
Projecting a Maximum Value for Cd

- We must consider
  - Effluent variability - defined by the coefficient of variation (CV)
  - Uncertainty due to a limited number of data points
  - Desired upper-bound of the expected lognormal distribution



Statistical Approach

- **Selected Percentile**
  - **What is the upper bound value of the discharge pollutant concentration that we want to determine?**
    - **99th percentile?**
    - **95th percentile?**
    - **Other?**



EPA

Statistical Approach

- Confidence Level
  - What confidence level do we want for our upper bound value?
    - 99% confidence?
    - 95% confidence?
    - Other?
  - At the 99% confidence level:
    - the largest value of 5 samples is greater than the 40th percentile
    - the largest value of 330 samples is greater than the 99th percentile

Projecting a Maximum Value for Cd

- How do you determine Cd with a 99% confidence level at the 99% upper bound?
  - Options:
    1) Take the maximum value of 330 or more samples
    2) Project a maximum value from existing data using a multiplier

Reasonable Potential Multiplying Factors

(99% Confidence Level and 99% Probability Basis)

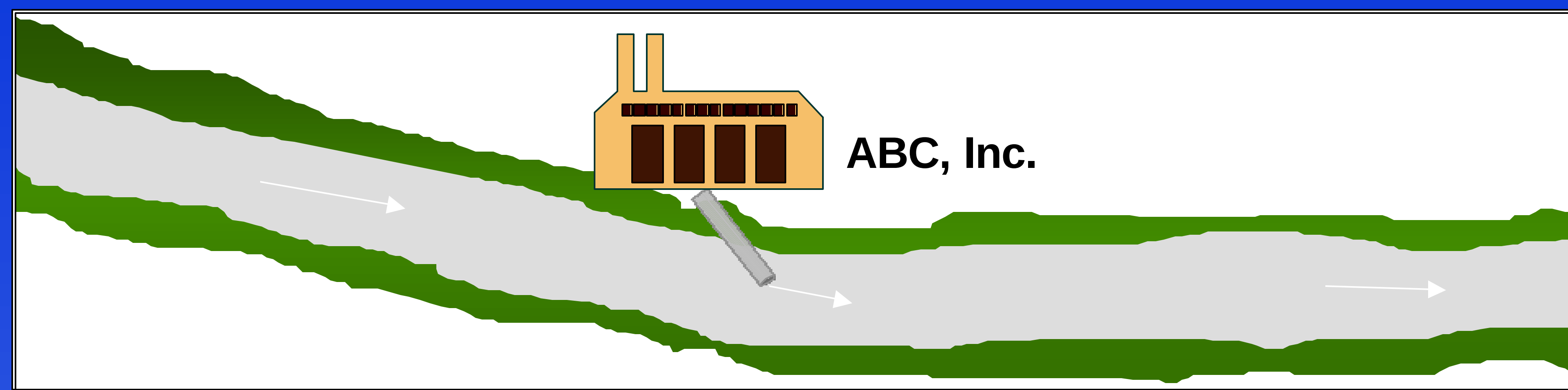
Sample Number	Coefficient of Variation									
N	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
1	2.5	6.0	13.2	26.5	48.3	81.4	128.0	190.3	269.9	368.3
2	2.0	4.0	7.4	12.7	20.2	30.3	43.0	58.4	76.6	97.5
3	1.9	3.3	5.6	8.9	13.4	19.0	25.7	33.5	42.3	52.0
4	1.7	2.9	4.7	7.2	10.3	14.2	18.6	23.6	29.1	35.1
5	1.7	2.7	4.2	6.2	8.6	11.5	14.8	18.4	22.4	26.5
6	1.6	2.5	3.8	5.5	7.5	9.8	12.4	15.3	18.3	21.5
7	1.6	2.4	3.6	5.0	6.7	8.7	10.8	13.1	15.6	18.2
8	1.5	2.3	3.3	4.6	6.1	7.8	9.6	11.6	13.6	15.8
9	1.5	2.2	3.2	4.3	5.7	7.1	8.7	10.4	12.2	14.0
10	1.5	2.2	3.0	4.1	5.3	6.6	8.0	9.5	11.0	12.6
11	1.4	2.1	2.9	3.9	5.0	6.2	7.4	8.8	10.1	11.5
12	1.4	2.0	2.8	3.7	4.7	5.8	7.0	8.1	9.4	10.6
13	1.4	2.0	2.7	3.6	4.5	5.5	6.5	7.6	8.7	9.9
14	1.4	2.0	2.6	3.4	4.3	5.2	6.2	7.2	8.2	9.2
15	1.4	1.9	2.6	3.3	4.1	5.0	5.9	6.8	7.7	8.7
16	1.4	1.9	2.5	3.2	4.0	4.8	5.6	6.5	7.3	8.2
17	1.4	1.9	2.5	3.1	3.8	4.6	5.4	6.2	7.0	7.8
18	1.4	1.9	2.4	3.0	3.7	4.4	5.2	5.9	6.7	7.4
19	1.4	1.8	2.4	3.0	3.6	4.3	5.0	3.7	6.4	7.1
20	1.3	1.8	2.3	2.9	3.5	4.2	4.8	5.5	6.1	6.8

Projecting a Maximum Value for Cd

- Re-examine data for ABC, Inc.
  - Number of samples (n) = 8
  - CV = 0.6 (default value if n < 10
  - Maximum Observed Value of Effluent Concentration (Cd) = 1.5 mg/l
  - Projected Maximum Value of Cd = 1.5 mg/l x multiplier
    = 1.5 mg/l x 3.3
    = 5.0 mg/l

EPA

Is There Reasonable Potential to Exceed Water Quality Standards?



Qs	=	Upstream river flow	1Q10	=	1.2 cfs
Qd	=	Discharge flow		=	0.31 cfs
Cs	=	Upstream river concentration		=	0.8 mg/l
Cd	=	*Maximum observed* discharge concentration		=	1.5 mg/l
		Water Quality Standard (Acute Criterion)		=	1.0 mg/l

$$Cr = \frac{QdCd + QsCs}{Qr}$$

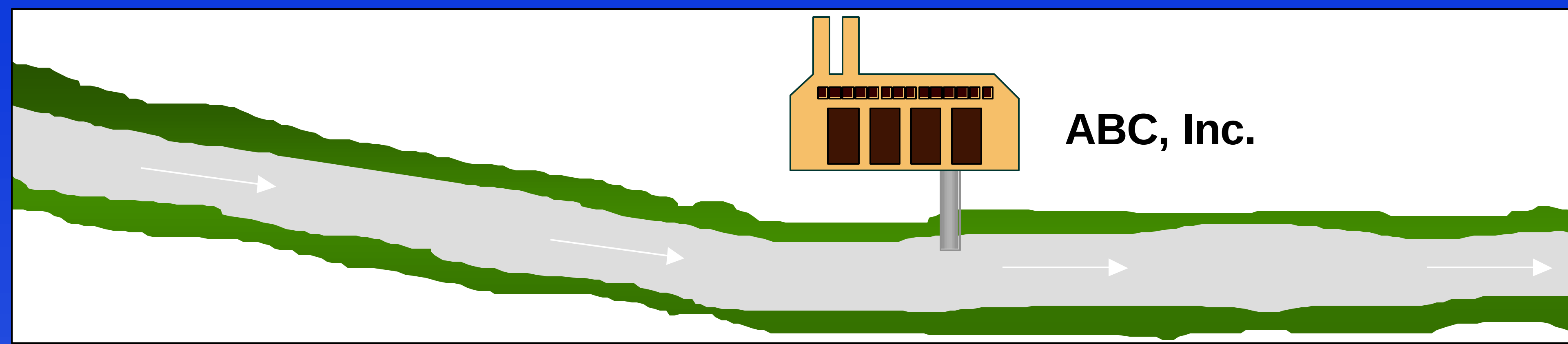
Is There Reasonable Potential to Exceed Water Quality Standards? (Continued)

- Projected maximum Cd = 1.5 mg/l x 3.3 = 5.0 mg/l
- Cr = $\frac{(0.31)(5.0) + (1.2)(0.8)}{1.2 + 0.31}$

  = 1.7 mg/l

  1.7 mg/l > 1.0 mg/l (WQS - Acute criterion)

What is the maximum allowable pollutant concentration in the ABC, Inc. effluent assuming complete mixing?



Qs = Upstream river flow 1Q10 = 1.2 cfs

7Q10 =

3.6 cfs

Qd = Discharge flow = 0.31 cfs

Cs = Upstream river conc. = 0.8 mg/l

Cr = Water Quality Criterion

Acute = 1.0 mg/l (applied at 1Q10)

Chronic = 0.9 mg/l (applied at 7Q10)

$$Cd = WLA = \frac{Cr(Qd + Qs) - CsQs}{Qd}$$

$Cd_{(acute)} = WLA_a = 1.8$ mg/l

$Cd_{(chronic)} = WLA_c = 2.1$ mg/l

EPA

Steps in Developing Chemical-Specific Water Quality-Based Effluent Limits

Acute and Chronic Wasteload Allocations (WLAs)

↓

Step 1: Calculate Long-Term Average (LTA) for Both WLAs

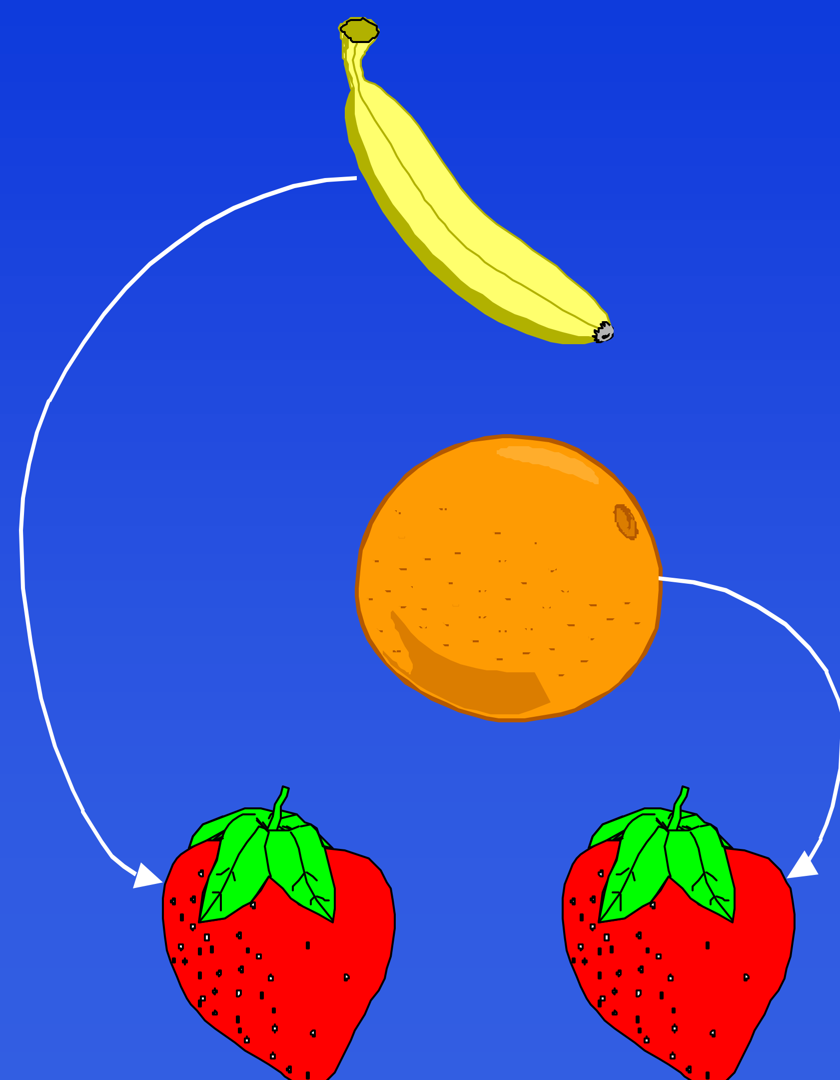
↓

Step 2: Select Lowest LTA

↓

Step 3: Calculate Maximum Daily Limit (MDL) and Average Monthly Limit (AML)

We All Want to Use the Same Fruit



$= WLA_a$

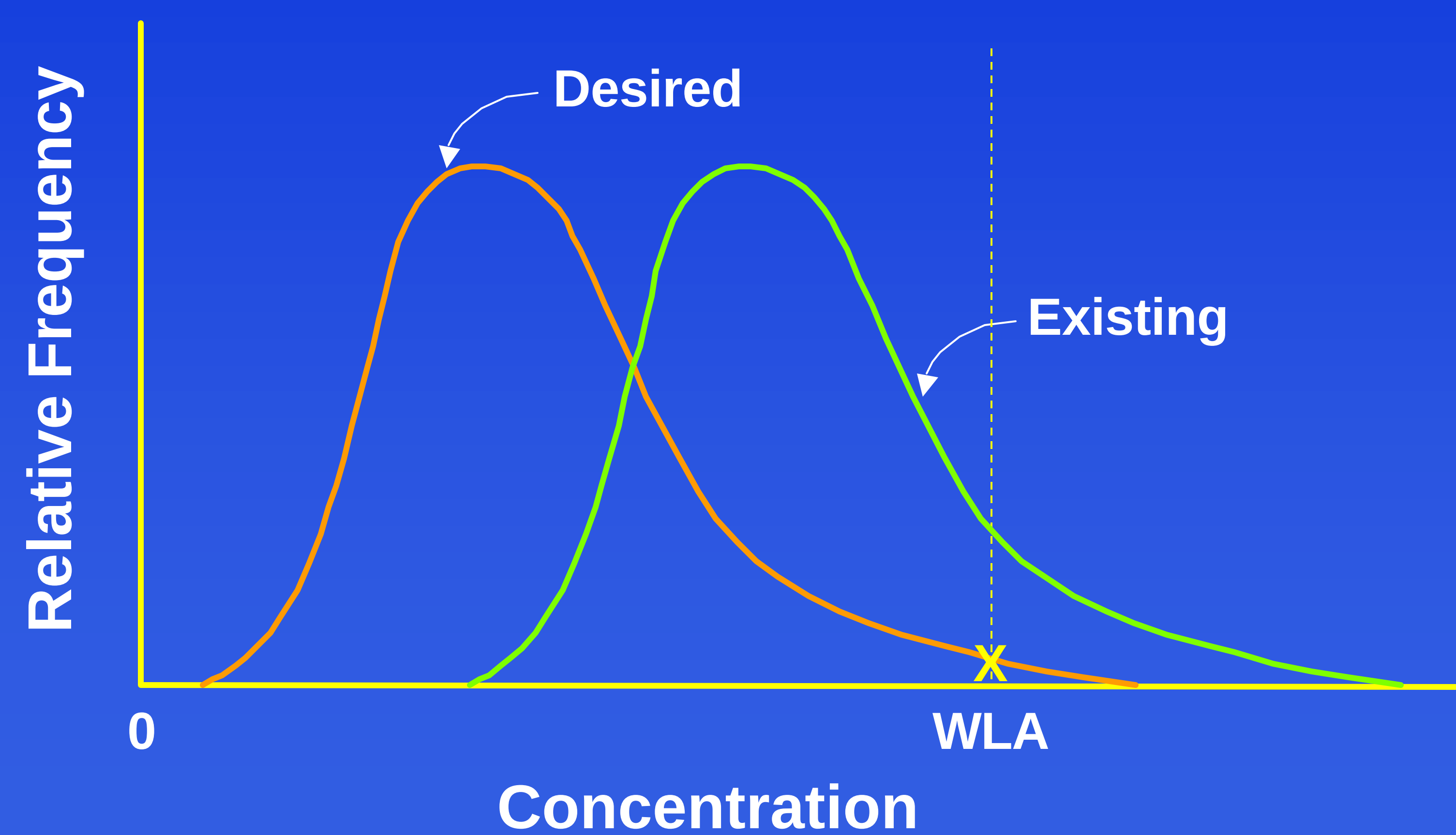
$= WLA_c$

$= LTA$

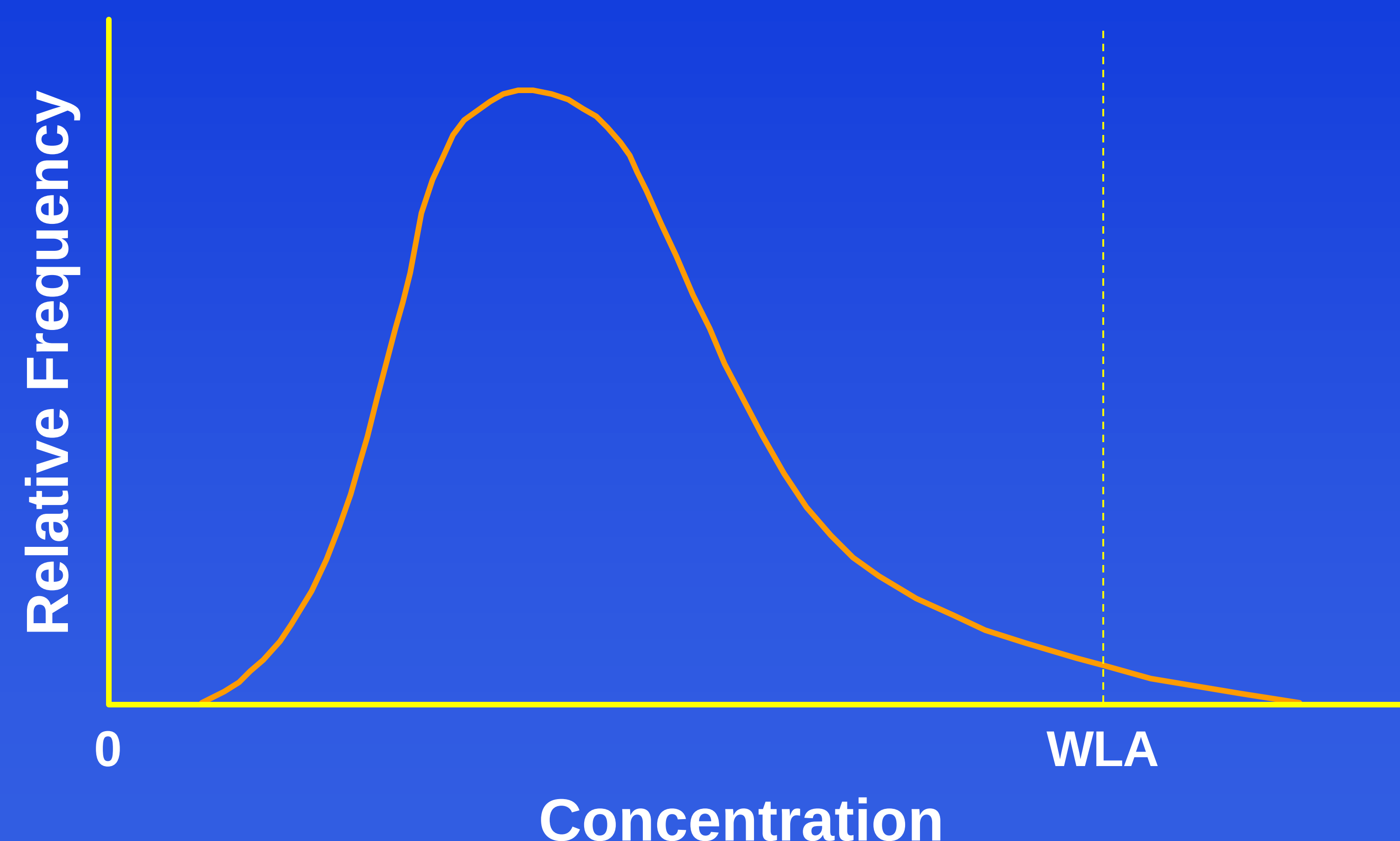
Step 1: Calculate LTAs

- Wasteload allocation (WLA) is "never to be exceeded"
- Assume a log normal effluent distribution
- Characterize "never to be exceeded" by a probability (e.g., WLA is the 99th percentile concentration on the log normal effluent distribution)

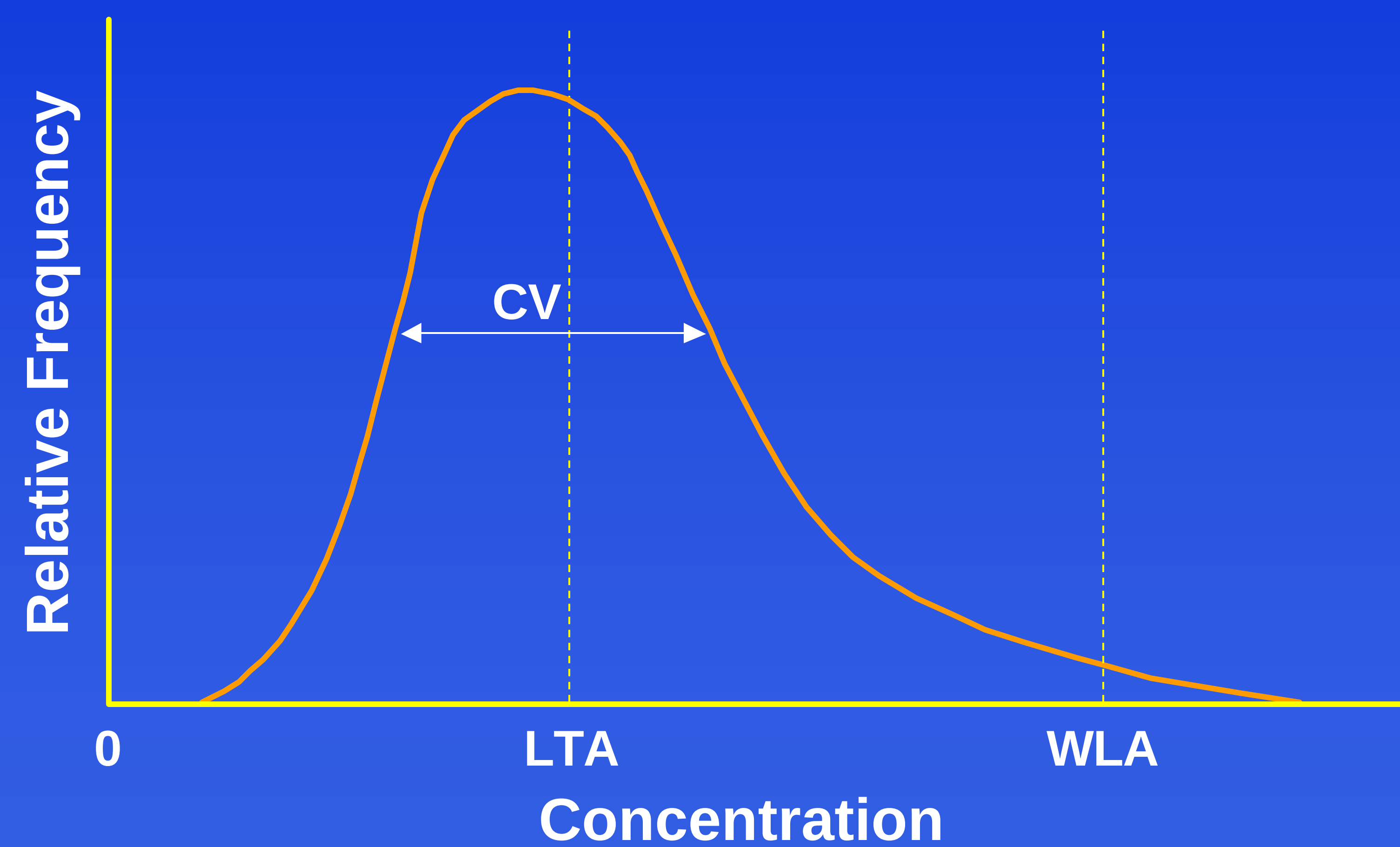
Goal is to Reduce Effluent Concentrations to Below the WLA



This Distribution Achieves the Goal



We Can Characterize the Desired Distribution by LTA and CV



CV	WLA multipliers $e^{[0.5\,s^2 - zs]}$ 95th percentile	99th percentile
0.1	0.853	0.797
0.2	0.736	0.643
0.3	0.644	0.527
0.4	0.571	0.440
0.5	0.514	0.373
0.6	0.468	0.321
0.7	0.432	0.281
0.8	0.403	0.249
0.9	0.379	0.224
1.0	0.360	0.204
1.1	0.344	0.187
1.2	0.330	0.174
1.3	0.319	0.162
1.4	0.310	0.153
1.5	0.302	0.144
1.6	0.296	0.137
1.7	0.290	0.131
1.8	0.285	0.126
1.9	0.281	0.121
2.0	0.277	0.117

Acute

$LTA_a = WLA_a \cdot e^{[0.5\,s^2 - zs]}$

where: $s^2 = ln[CV^2 + 1]$

z = 1.645 for 95th percentile occurrence probability, and

z = 2.326 for 99th percentile occurrence probability

Chronic
(4-day average)

CV	WLA multipliers $e^{[0.5 s_4^2 - z s_4]}$ 95th percentile	99th percentile
0.1	0.922	0.891
0.2	0.853	0.797
0.3	0.791	0.715
0.4	0.736	0.643
0.5	0.687	0.581
0.6	0.644	0.527
0.7	0.606	0.481
0.8	0.571	0.440
0.9	0.541	0.404
1.0	0.514	0.373
1.1	0.490	0.345
1.2	0.468	0.321
1.3	0.449	0.300
1.4	0.432	0.281
1.5	0.417	0.264
1.6	0.403	0.249
1.7	0.390	0.236
1.8	0.379	0.224
1.9	0.369	0.214
2.0	0.360	0.204

$LTA_c = WLA_c \cdot e^{[0.5 s_4^2 - z s_4]}$

where: $s_4^2 = ln[CV^2/4 + 1]$

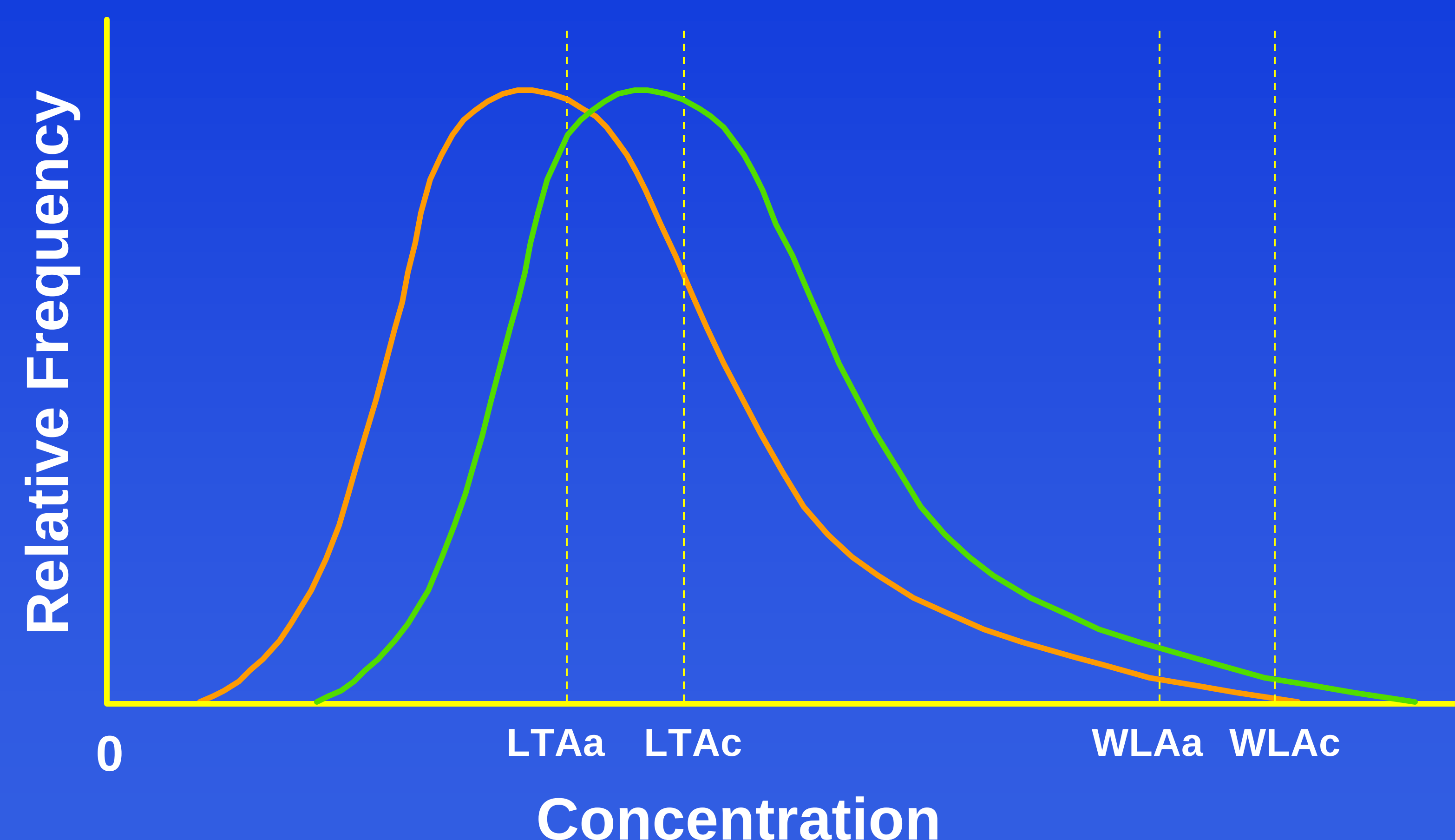
z = 1.645 for 95th percentile occurrence probability, and

z = 2.326 for 99th percentile occurrence probability

Step 2: Select Lowest LTA

- Protects both WLAs (acute and chronic)
- Sets one basis for facility performance

Because There Are Two LTAs, We Need to Use the More Stringent



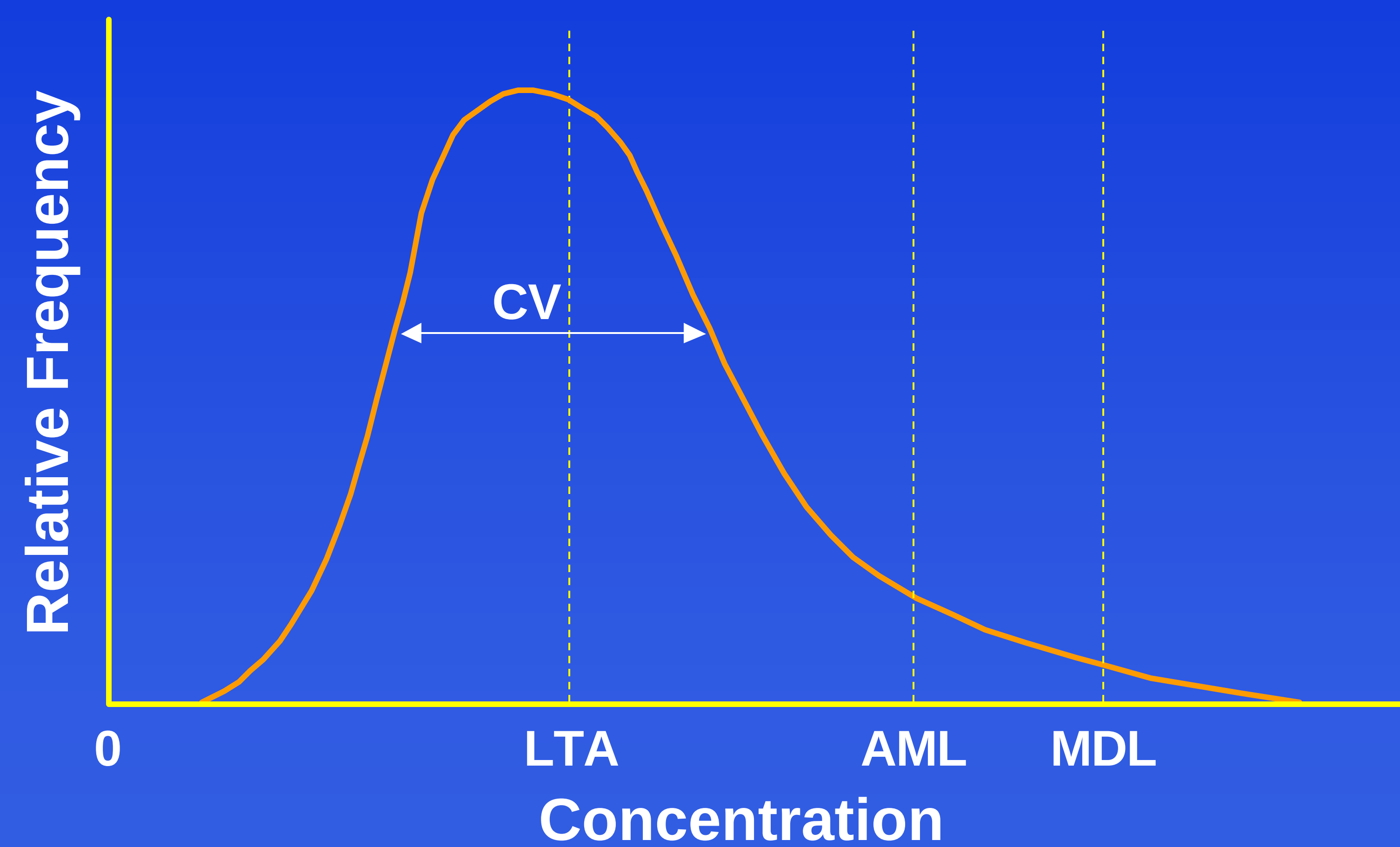
EPA

Step 3: Calculate MDL and AML

- Allows comparison to technology-based limits
- Uses upper-bound estimates for both MDL and AML
- Ties AML to planned frequency of monitoring

EPA

We Can Characterize the Upper Bounds of the Effluent from the LTA and CV



Maximum Daily Limit (MDL)

$MDL = LTA \cdot e^{[z\sigma - 0.5\sigma^2]}$

where: $\sigma^2 = ln[CV^2 + 1]$

$z = 1.645$ for 95th percentile occurrence probability, and

$z = 2.326$ for 99th percentile occurrence probability

CV	LTA multipliers $e^{[z\sigma - 0.5\sigma^2]}$ 95th percentile	99th percentile
0.1	1.17	1.25
0.2	1.36	1.55
0.3	1.55	1.90
0.4	1.75	2.27
0.5	1.95	2.68
0.6	2.13	3.11
0.7	2.31	3.56
0.8	2.48	4.01
0.9	2.64	4.46
1.0	2.78	4.90
1.1	2.91	5.34
1.2	3.03	5.76
1.3	3.13	6.17
1.4	3.23	6.56
1.5	3.31	6.93
1.6	3.38	7.29
1.7	3.45	7.63
1.8	3.51	7.95
1.9	3.56	8.26
2.0	3.60	8.55

EPA

Average Monthly Limit

$$AML = LTA \cdot e^{[z s_n - 0.5 s_n^{2}]}$$

where: $s_n^{2} = \mathit{ln}[CV^2/n + 1]$.

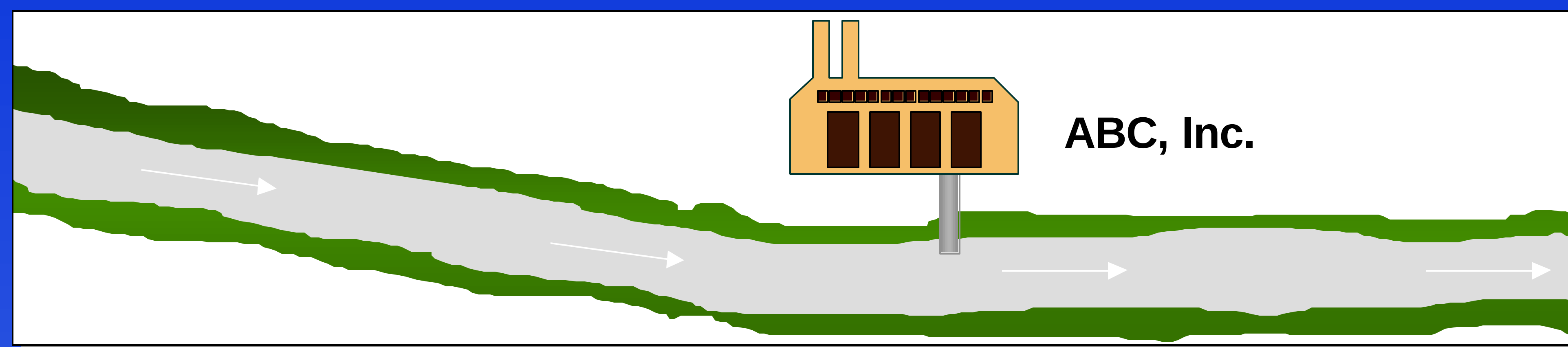
$z = 1.645$ for 95th percentile occurrence probability, and

$z = 2.326$ for 99th percentile occurrence probability

n = number of samples/month.

CV	LTA multipliers $e^{[z s_n - 0.5 s_n^{2}]}$ — 95th percentile					99th percentile				
	n=1	n=2	n=4	n=8	n=30	n=1	n=2	n=4	n=10	n=30
0.1	1.17	1.12	1.08	1.06	1.03	1.25	1.18	1.12	1.08	1.04
0.2	1.36	1.25	1.17	1.12	1.06	1.56	1.37	1.25	1.16	1.08
0.3	1.55	1.38	1.26	1.18	1.09	1.90	1.59	1.40	1.24	1.13
0.4	1.75	1.52	1.36	1.25	1.12	2.27	1.83	1.55	1.33	1.18
0.5	1.96	1.66	1.45	1.31	1.16	2.68	2.09	1.72	1.42	1.23
0.6	2.13	1.90	1.55	1.38	1.19	3.11	2.37	1.90	1.52	1.28
0.7	2.31	1.94	1.65	1.45	1.22	3.56	2.66	2.08	1.62	1.33
0.8	2.48	2.07	1.75	1.52	1.26	4.01	2.96	2.27	1.73	1.39
0.9	2.64	2.20	1.85	1.59	1.29	4.46	3.28	2.48	1.84	1.44
1.0	2.78	2.33	1.95	1.66	1.33	4.90	3.59	2.68	1.96	1.50
1.1	2.91	2.45	2.04	1.73	1.36	5.34	3.91	2.90	2.07	1.56
1.2	3.03	2.56	2.13	1.80	1.39	5.76	4.23	3.11	2.19	1.62
1.3	3.13	2.67	2.23	1.87	1.43	6.17	4.55	3.34	2.32	1.68
1.4	3.23	2.77	2.31	1.94	1.47	6.56	4.86	3.56	2.45	1.74
1.5	3.31	2.86	2.40	2.00	1.50	6.93	5.17	3.78	2.58	1.80
1.6	3.38	2.95	2.48	2.07	1.54	7.29	5.47	4.01	2.71	1.87
1.7	3.45	3.03	2.56	2.14	1.57	7.63	5.77	4.23	2.84	1.93
1.8	3.51	3.10	2.64	2.20	1.61	7.95	6.06	4.46	2.98	2.00
1.9	3.56	3.17	2.71	2.27	1.64	8.26	6.34	4.68	3.12	2.07
2.0	3.60	3.23	2.78	2.33	1.68	8.55	6.61	4.90	3.26	2.14

Example



Recall that we calculated the following WLAs:

Cd(acute)	=	1.8 mg/l
Cd(chronic)	=	2.1 mg/l

Step 1: Calculate LTAs

CV	WLA multipliers $e^{[0.5\sigma^2 - z\sigma]}$ 95th percentile	99th percentile
0.1	0.853	0.797
0.2	0.736	0.643
0.3	0.644	0.527
0.4	0.571	0.440
0.5	0.514	0.373
0.6	0.468	0.321
0.7	0.432	0.281
0.8	0.403	0.249
0.9	0.379	0.224
1.0	0.360	0.204
1.1	0.344	0.187
1.2	0.330	0.174
1.3	0.319	0.162
1.4	0.310	0.153
1.5	0.302	0.144
1.6	0.296	0.137
1.7	0.290	0.131
1.8	0.285	0.126
1.9	0.281	0.121
2.0	0.277	0.117

Acute

CV = 0.6

WLA(acute) = 1.8 mg/l
= 99th percentile value

LTA(acute) = 1.8 mg/l x 0.321
= 0.58 mg/l

Step 1: Calculate LTAs

CV	WLA multipliers $e^{[0.5\sigma_4^2 - z\sigma_4]}$ 95th percentile	WLA multipliers $e^{[0.5\sigma_4^2 - z\sigma_4]}$ 99th percentile
0.1	0.922	0.891
0.2	0.853	0.797
0.3	0.791	0.715
0.4	0.736	0.643
0.5	0.687	0.581
0.6	0.644	0.527
0.7	0.606	0.481
0.8	0.571	0.440
0.9	0.541	0.404
1.0	0.514	0.373
1.1	0.490	0.345
1.2	0.468	0.321
1.3	0.449	0.300
1.4	0.432	0.281
1.5	0.417	0.264
1.6	0.403	0.249
1.7	0.390	0.236
1.8	0.379	0.224
1.9	0.369	0.214
2.0	0.360	0.204

Chronic

CV = 0.6

WLA(chronic) = 2.1 mg/l
= 99th percentile value

LTA(chronic) = 2.1 mg/l x 0.527
= 1.1 mg/l

Step 2: Select Lowest LTA

- LTA(acute) = 0.58 mg/l
- LTA(chronic) = 1.1 mg/l
- Select LTA(acute) = 0.58 mg/l

Step 3: Calculate MDL and AML

CV	LTA multipliers $e^{[z\sigma - 0.5\sigma^2]}$ 95th percentile	99th percentile
0.1	1.17	1.25
0.2	1.36	1.55
0.3	1.55	1.90
0.4	1.75	2.27
0.5	1.95	2.68
0.6	2.13	3.11
0.7	2.31	3.56
0.8	2.48	4.01
0.9	2.64	4.46
1.0	2.78	4.90
1.1	2.91	5.34
1.2	3.03	5.76
1.3	3.13	6.17
1.4	3.23	6.56
1.5	3.31	6.93
1.6	3.38	7.29
1.7	3.45	7.63
1.8	3.51	7.95
1.9	3.56	8.26
2.0	3.60	8.55

MDL

CV = 0.6

MDL = 99th percentile value

MDL = 0.58 mg/l x 3.11
= 1.8 mg/l

Step 3: Calculate MDL and AML
(Continued)

LTA multipliers

$e^{[z s_n - 0.5 s_n^2]}$

CV	95th percentile					99th percentile				
	n=1	n=2	n=4	n=8	n=30	n=1	n=2	n=4	n=10	n=30
0.1	1.17	1.12	1.08	1.06	1.03	1.25	1.18	1.12	1.08	1.04
0.2	1.36	1.25	1.17	1.12	1.06	1.56	1.37	1.25	1.16	1.08
0.3	1.55	1.38	1.26	1.18	1.09	1.90	1.59	1.40	1.24	1.13
0.4	1.75	1.52	1.36	1.25	1.12	2.27	1.83	1.55	1.33	1.18
0.5	1.96	1.66	1.45	1.31	1.16	2.68	2.09	1.72	1.42	1.23
0.6	2.13	1.90	1.55	1.38	1.19	3.11	2.37	1.90	1.52	1.28
0.7	2.31	1.94	1.65	1.45	1.22	3.56	2.66	2.08	1.62	1.33
0.8	2.48	2.07	1.75	1.52	1.26	4.01	2.96	2.27	1.73	1.39
0.9	2.64	2.20	1.85	1.59	1.29	4.46	3.28	2.48	1.84	1.44
1.0	2.78	2.33	1.95	1.66	1.33	4.90	3.59	2.68	1.96	1.50
1.1	2.91	2.45	2.04	1.73	1.36	5.34	3.91	2.90	2.07	1.56
1.2	3.03	2.56	2.13	1.80	1.39	5.76	4.23	3.11	2.19	1.62
1.3	3.13	2.67	2.23	1.87	1.43	6.17	4.55	3.34	2.32	1.68
1.4	3.23	2.77	2.31	1.94	1.47	6.56	4.86	3.56	2.45	1.74
1.5	3.31	2.86	2.40	2.00	1.50	6.93	5.17	3.78	2.58	1.80
1.6	3.38	2.95	2.48	2.07	1.54	7.29	5.47	4.01	2.71	1.87
1.7	3.45	3.03	2.56	2.14	1.57	7.63	5.77	4.23	2.84	1.93
1.8	3.51	3.10	2.64	2.20	1.61	7.95	6.06	4.46	2.98	2.00
1.9	3.56	3.17	2.71	2.27	1.64	8.26	6.34	4.68	3.12	2.07
2.0	3.60	3.23	2.78	2.33	1.68	8.55	6.61	4.90	3.26	2.14

AML

Number of Samples = 8 (assume twice-weekly sampling)

CV = 0.6

AML = 95th percentile value

AML = 0.58 mg/l x 1.38
= 0.80 mg/l

Whole Effluent Toxicity

EPA

Learning Objectives

- Foster better understanding of scientific underpinnings of WET
  - Describe uses and limitations
- Discuss WET implementation and methods requirements
- Explain the purpose of toxicity reduction evaluations
- Show how WET is similar to chemical evaluations

EPA

What is Whole Effluent Toxicity (WET) Testing?

- Part of water quality-based toxics control approach
- Measures the aggregate toxic effect of effluent or ambient water
  - measures the response of exposed aquatic organisms

EPA

Why WET?

- Allows for the protection of the narrative criterion "no toxics in toxic amounts"
  - Implementation Policy
- Integrated Approach to Water Quality-Based Toxics Control
  - Chemical specific approach
  - Biological criteria approach
  - Whole effluent toxicity approach

EPA

Acute Toxicity

- **Acute Tests**
  - **Test duration: 96 hours or less**
  - **Endpoint: Mortality (expressed as LC_{50})**
  - **Example: *Pimephales promelas* (fathead minnow) 96 hour test**

Chronic Toxicity

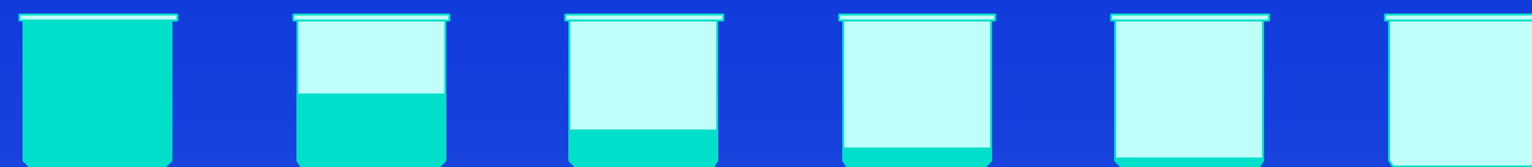
- Short-term Chronic Tests
  - Test duration: 1.5 hours (sea urchins) to 9 days (sheepshead minnows)
  - Endpoint: Growth, reproduction, etc., (expressed as NOEC, LOEC, or IC_{25})
  - Example: *Ceriodaphnia dubia* (water flea) 7-day reproduction test

Acute WET Statistical Endpoints: Definitions

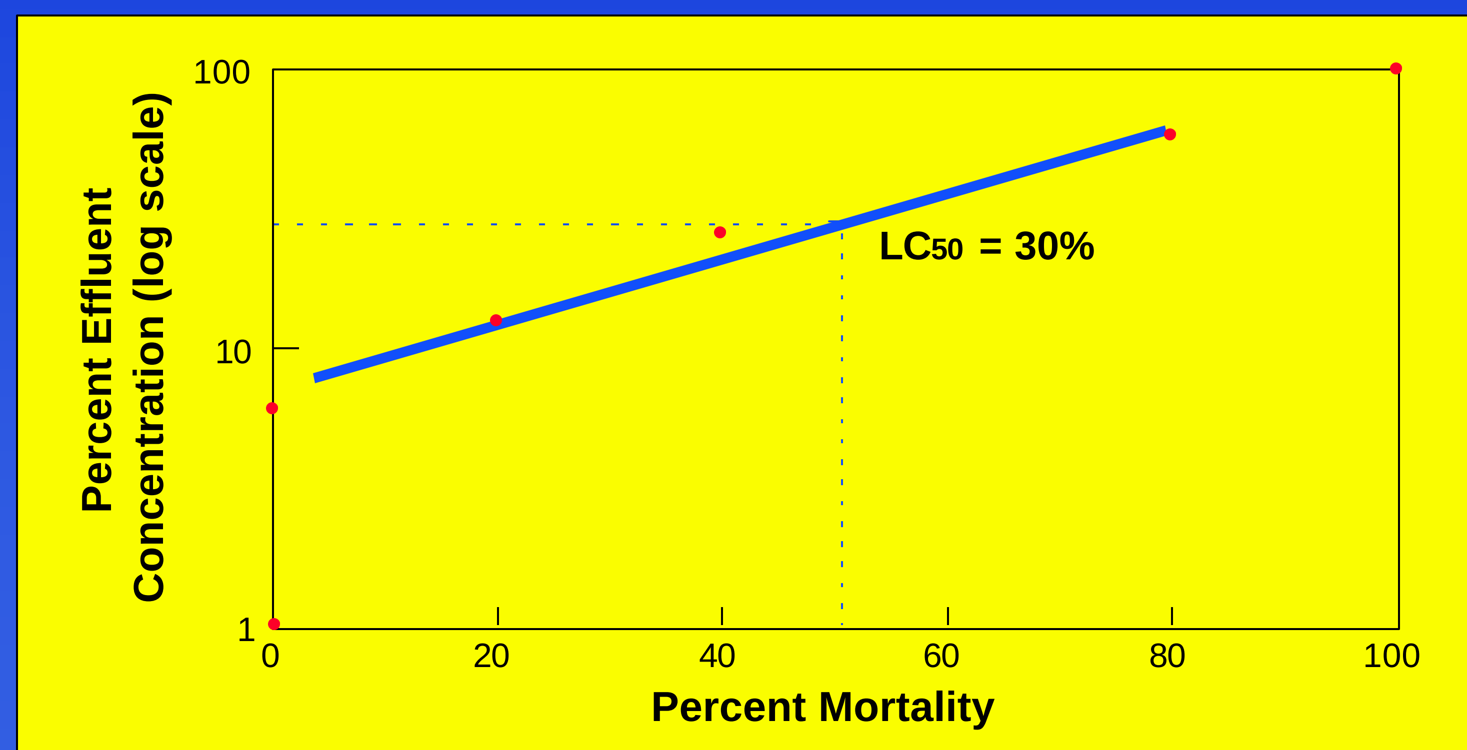
- LC_{50}
  - Concentration of effluent that is lethal to 50 percent of the exposed organisms
    - uses a dilution series
- pass/fail
  - instream waste concentration (IWC) or ambient toxicity test measured against a control

Example of Acute Test Data and Statistical Analysis

100%	50%	25%	12.5%	6.25%	0%	% Effluent Concentration



100%	80%	40%	20%	0%	0%	% Mortality



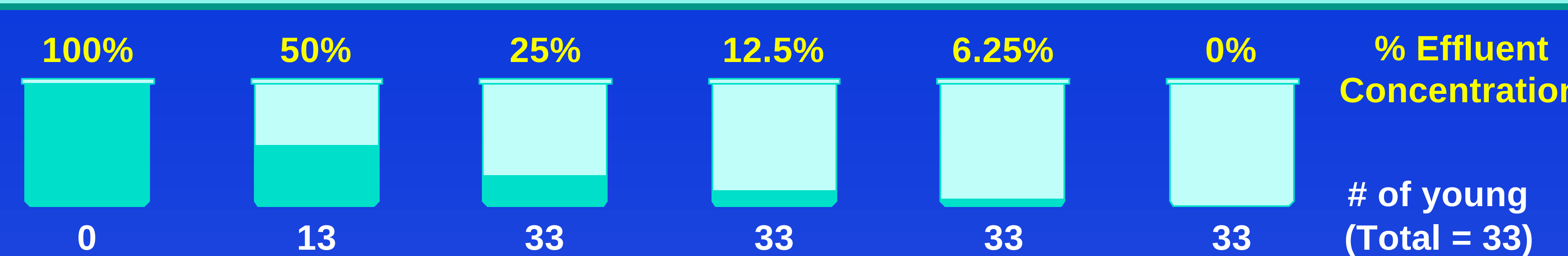
Example of Pass/Fail Acute Test at IWC or Ambient

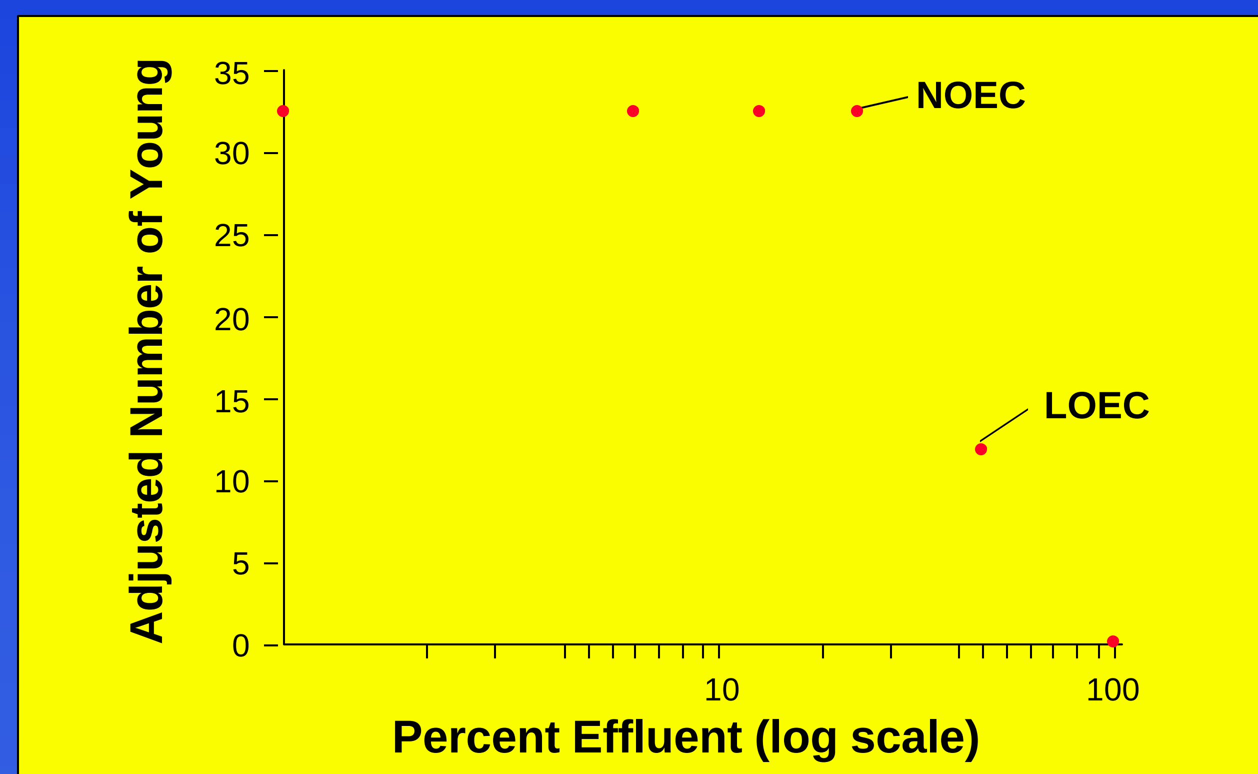
- Instream Waste Concentration (IWC) equals 75%
- Statistical evaluation using student-t test compares mortality rates of ambient or IWC sample against the control
  - Is there a “significant statistical difference”?

Chronic WET Statistical Endpoints (Hypothesis Testing)

- NOEC
  - No Observed Effect Concentration (NOEC) - the highest concentration of an effluent or a toxicant at which no adverse effects are observed on the aquatic test organisms

Example of Chronic Test Data



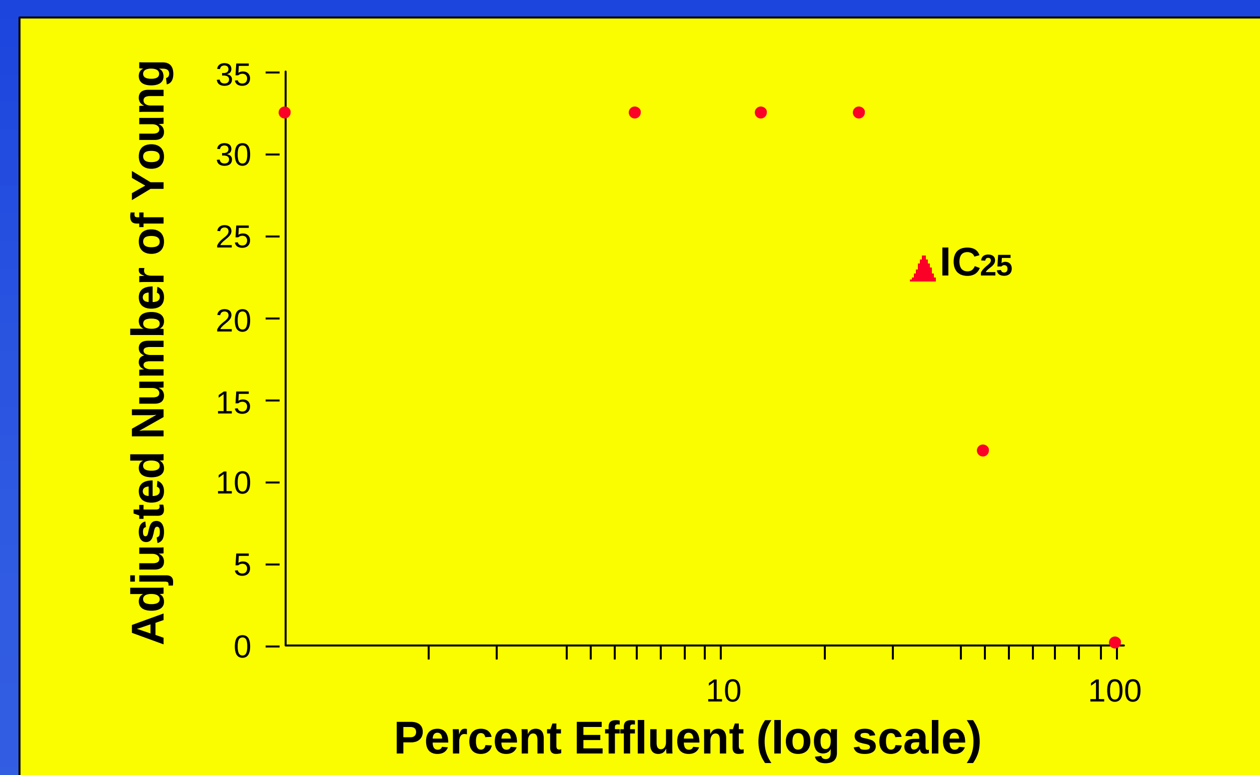


Chronic WET Statistical Endpoints (Point Estimates)

Inhibition Conc. (IC_p)

- A point estimate of the toxicant of effluent concentration that would cause:
  - (IC_p) a given percent reduction in a nonlethal biological measurement of the test organisms (e.g., reproduction, growth)

Example of Determining an IC25 from Chronic Test Data



Considerations When Selecting Toxicity Test Methods

- Approved acute and chronic methods found in 40 CFR Part 136
- Must determine:
  - Acute or chronic toxicity (based on calculated limits or available dilution)
  - Fresh water or marine discharge
  - Most appropriate species (e.g., three species quarterly for 1 year)

Options for Expressing WET Values

- **Option A**
  - Use statistical endpoint (e.g., LC_{50}, NOEC, LOEC, or IC_{25}) directly

    Example: LC_{50} = 30% effluent
- **Option B**
  - Use toxic units

$$TUa = \frac{100}{LC_{50}}$$

$$TUc = \frac{100}{NOEC}$$

Examples of Toxic Units

- **Acute (TUa)**
  - Assuming LC_{50} = 28%

$$TUa = \frac{100}{LC_{50}} = \frac{100}{28} = 3.6$$

- **Chronic (TUc)**
  - Assuming NOEC = 50%

$$TUc = \frac{100}{NOEC} = \frac{100}{50} = 2.0$$

  - Assuming IC_{25} = 30%

$$TUc = \frac{100}{IC_{25}} = \frac{100}{30} = 3.3$$

EPA

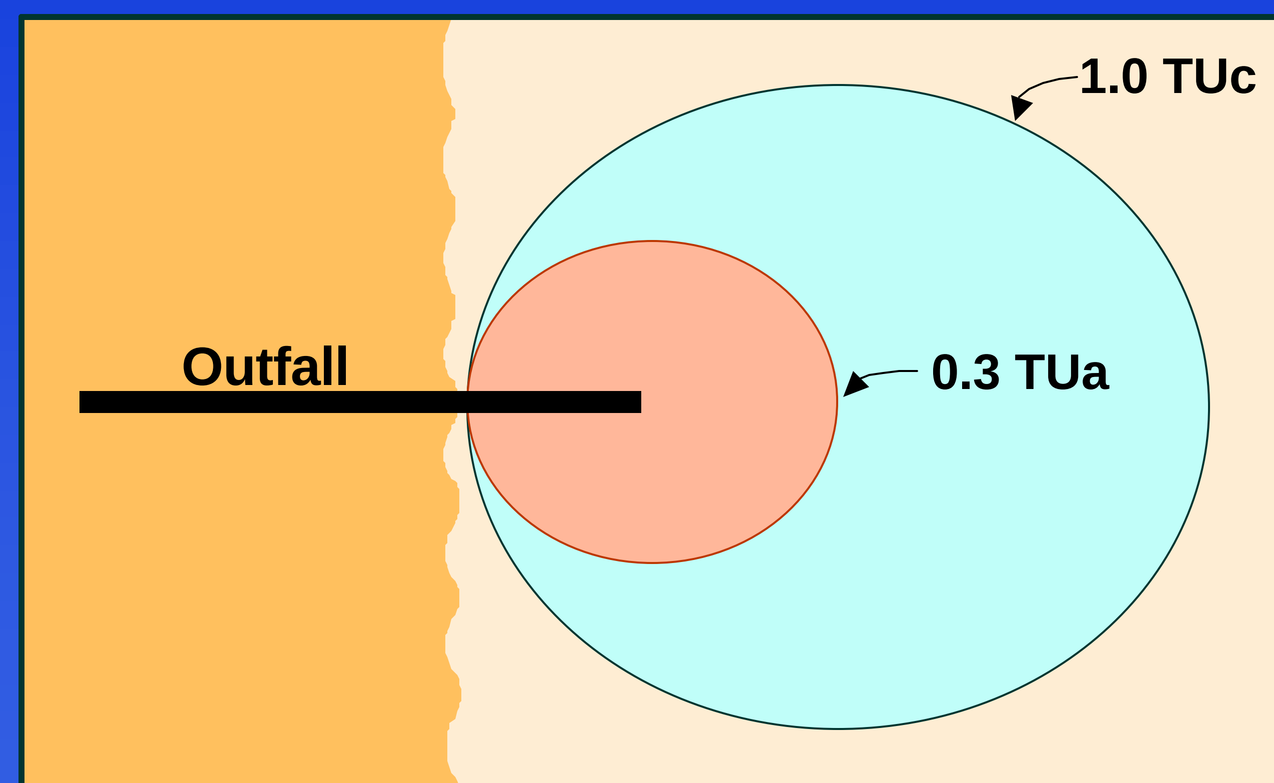
Whole Effluent Toxicity Criteria

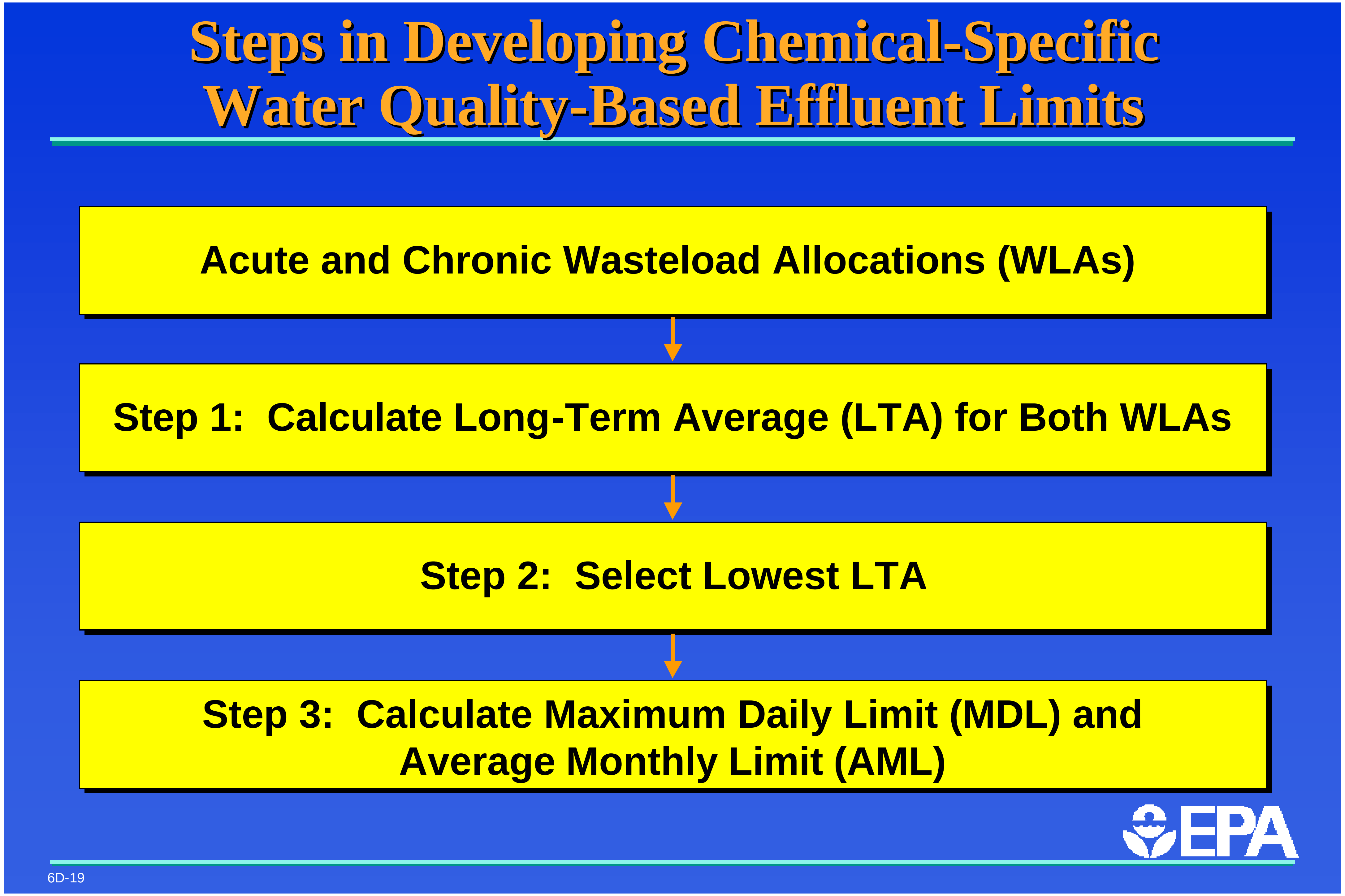
- **Narrative - "no toxics in toxic amounts"**
- **Numeric - (TSD recommendations) or (numeric interpretation of Narrative)**
  - **Acute = 0.3 TUa (e.g., $\frac{100}{LC_{50}}$)**
  - **Chronic = 1.0 TUc (e.g., $\frac{100}{NOEC}$)**

EPA

Whole Effluent Toxicity Criteria
(Continued)

Applying toxicity criteria with allowable dilution:




Steps in Developing Chemical-Specific Water Quality-Based Effluent Limits
Acute and Chronic Wasteload Allocations (WLAs)
Step 1: Calculate Long-Term Average (LTA) for Both WLAs
Step 2: Select Lowest LTA
Step 3: Calculate Maximum Daily Limit (MDL) and Average Monthly Limit (AML)
EPA
6D-19

Steps in Developing WET Permit Limitations

Acute and Chronic Wasteload Allocations

Step 1: Convert Acute WLA into Chronic WLA (WET only)

Step 2: Calculate LTA for Both

Step 3: Select Lowest LTA

Step 4: Calculate Maximum and Average Limits

EPA

Definition of Acute-Chronic Ratio

- Acute-chronic ratio (ACR) - the ratio of the acute toxicity of an effluent or a toxicant to its chronic toxicity
- Calculated as the average of the ratios between at least 10 pairs of acute and chronic toxicity test results for the same species
- Default ACR = 10 in the absence of data to develop an ACR

EPA

Example ACR Calculations

Using test results expressed as percent effluent:

$$ACR = \frac{LC_{50}}{NOEC} = \frac{65\%}{25\%} = 2.6$$

Using test results expressed as toxic units:

$$ACR = \frac{TUc}{TUa} = \frac{4.0}{1.5} = 2.6$$

Why an ACR?

- Acute and chronic toxicity test results are not directly comparable
- ACR is a factor for estimating chronic toxicity on the basis of acute toxicity data, or for estimating acute toxicity on the basis of chronic toxicity data
- Allows expression of toxicity results or requirements in the same units

Example Step 1

WLAa = 1.5 TUa   WLAc = 16 TUc

Observed ACR = 8.0

$WLA_{a,c}$ = Acute WLA expressed in TUc

$WLA_{a,c}$ = WLAa x ACR

$$= 1.5\ \cancel{TUa} \times 8.0 \left(\frac{TUc}{\cancel{TUa}}\right) = 12\ TUc$$

Steps in Developing WET Permit Limitations

Acute and Chronic Wasteload Allocations

Step 1: Convert Acute WLA into Chronic WLA (WET only)

Step 2: Calculate LTA for Both

Step 3: Select Lowest LTA

Step 4: Calculate Maximum and Average Limits

EPA

Toxicity Reduction Evaluations

- What is a TRE?
  - Procedures for investigating the causes and identifying corrective actions for effluent toxicity problems
- Why are TREs necessary?
  - Achieve compliance with limits or requirements for effluent toxicity contained in NPDES permits

EPA

Toxicity Reduction Evaluations (Continued)

- How are TREs performed?
- Site-specific study designed to:
  - Identify the causative agents of effluent toxicity
  - Isolate the sources of the toxicity
  - Evaluate the effectiveness of toxicity control options
  - Confirm the reduction in effluent toxicity

EPA

Mechanisms for Requiring TREs

- Special conditions in NPDES permit
- Section 308 letter
- Section 309 Administrative Order or a Consent Decree

EPA

Permits Must Specify

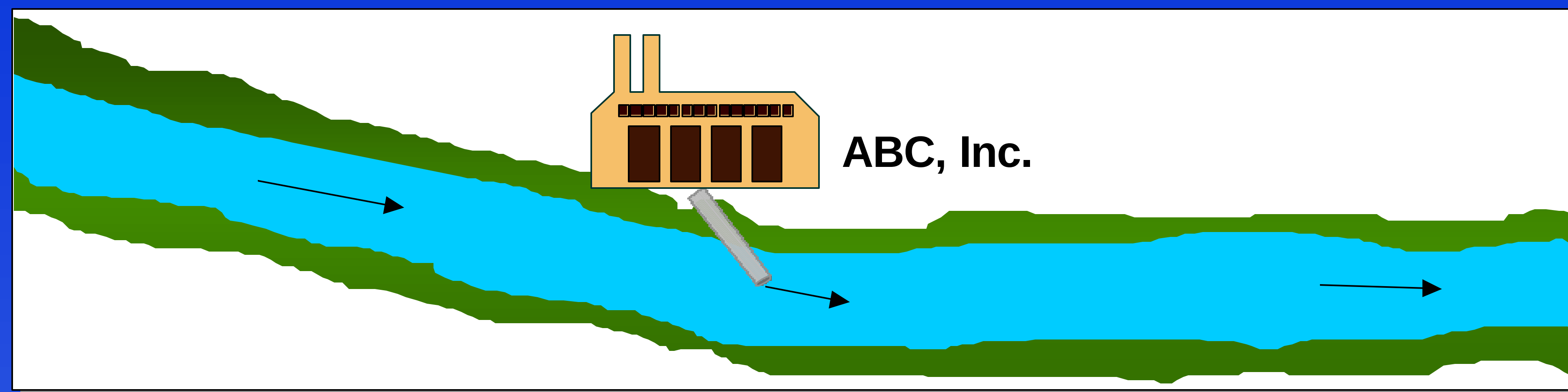
- Test species and method
- Testing frequency
- Statistical endpoints
- Steps to address toxicity

EPA

WET Example

Developing WET Effluent Limits

What is the Maximum Allowable Whole Effluent Toxicity for the ABC, Inc. Effluent Assuming Complete Mixing?



Qs = Upstream river flow

1Q10 = 1.2 cfs

7Q10 = 3.6 cfs

Qd = Discharge flow = 0.31 cfs

Cs = Upstream river concentration = 0 TUc

Cr = Water quality criteria
Acute = 0.3 TUa applied at 1Q10 low flow
Chronic = 1.0 TUc applied at 7Q10 low flow

EPA

Acute WLA

$$Cd = \frac{Cr(Qd + Qs) - CsQs}{Qd}$$

$$Cd\ Acute = \frac{0.3\ (0.31 + 1.2) - (0)(1.2)}{0.31}$$

$$Cd\ Acute = WLA_a = 1.5\ TUa$$

Chronic WLA

$$Cd = \frac{Cr(Qd + Qs) - CsQs}{Qd}$$

$$Cd\ chronic = \frac{1.0\ (0.31 + 3.6) - (0)(3.6)}{0.31}$$

$$Cd\ chronic = WLA_c = 13\ TUc$$

Step 1: Convert Acute WLA into Chronic Toxic Units

Observed ACR = 10

$WLA_{a,c}$ = Acute WLA expressed in TUc

$WLA_{a,c}$ = WLAa x ACR

$$= 1.5 \text{ TUa} \times 10 \left(\frac{\text{TUc}}{\text{TUa}}\right) = 15 \text{ TUc}$$

EPA

Step 2: Calculate LTAs

CV	WLA multipliers $e^{[0.5s^2 - zs]}$ 95th percentile	99th percentile
0.1	0.853	0.797
0.2	0.736	0.643
0.3	0.644	0.527
0.4	0.571	0.440
0.5	0.514	0.373
0.6	0.468	0.321
0.7	0.432	0.281
0.8	0.403	0.249
0.9	0.379	0.224
1.0	0.360	0.204
1.1	0.344	0.187
1.2	0.330	0.174
1.3	0.319	0.162
1.4	0.310	0.153
1.5	0.302	0.144
1.6	0.296	0.137
1.7	0.290	0.131
1.8	0.285	0.126
1.9	0.281	0.121
2.0	0.277	0.117

Acute LTA

CV = 0.6

WLAa,c = 15 TUc

= 99th percentile value

LTAa,c = 15 TUc x 0.321 = 4.8 TUc

EPA

Step 2: Calculate LTAs

CV	WLA multipliers $e^{[0.5s_4^2 - zs_4]}$ 95th percentile	99th percentile
0.1	0.922	0.891
0.2	0.853	0.797
0.3	0.791	0.715
0.4	0.736	0.643
0.5	0.687	0.581
0.6	0.644	0.527
0.7	0.606	0.481
0.8	0.571	0.440
0.9	0.541	0.404
1.0	0.514	0.373
1.1	0.490	0.345
1.2	0.468	0.321
1.3	0.449	0.300
1.4	0.432	0.281
1.5	0.417	0.264
1.6	0.403	0.249
1.7	0.390	0.236
1.8	0.379	0.224
1.9	0.369	0.214
2.0	0.360	0.204

Chronic LTA

CV = 0.6

WLAc = 13 TUc

= 99th percentile value

LTAc = 13 TUc x 0.527 = 6.9 TUc

EPA

Step 3: Select Lowest LTA

LTAa,c = 4.8 TUc

LTAc = 6.9 TUc

Select LTAa,c = 4.8 TUc

Step 4: Calculate MDL and AML

CV	LTA multipliers $e^{[zs - 0.5s^2]}$ 95th percentile	LTA multipliers $e^{[zs - 0.5s^2]}$ 99th percentile
0.1	1.17	1.25
0.2	1.36	1.55
0.3	1.55	1.90
0.4	1.75	2.27
0.5	1.95	2.68
0.6	2.13	3.11
0.7	2.31	3.56
0.8	2.48	4.01
0.9	2.64	4.46
1.0	2.78	4.90
1.1	2.91	5.34
1.2	3.03	5.76
1.3	3.13	6.17
1.4	3.23	6.56
1.5	3.31	6.93
1.6	3.38	7.29
1.7	3.45	7.63
1.8	3.51	7.95
1.9	3.56	8.26
2.0	3.60	8.55

MDL

CV = 0.6

MDL = 99th percentile value

MDL = 4.8 TUc x 3.11 = 15 TUc

Step 4: Calculate MDL and AML

LTA multipliers

$e^{[z\sigma_n - 0.5\sigma_n^2]}$

CV	95th percentile					99th percentile				
	n=1	n=2	n=4	n=8	n=30	n=1	n=2	n=4	n=10	n=30
0.1	1.17	1.12	1.08	1.06	1.03	1.25	1.18	1.12	1.08	1.04
0.2	1.36	1.25	1.17	1.12	1.06	1.56	1.37	1.25	1.16	1.08
0.3	1.55	1.38	1.26	1.18	1.09	1.90	1.59	1.40	1.24	1.13
0.4	1.75	1.52	1.36	1.25	1.12	2.27	1.83	1.55	1.33	1.18
0.5	1.96	1.66	1.45	1.31	1.16	2.68	2.09	1.72	1.42	1.23
0.6	2.13	1.90	1.55	1.38	1.19	3.11	2.37	1.90	1.52	1.28
0.7	2.31	1.94	1.65	1.45	1.22	3.56	2.66	2.08	1.62	1.33
0.8	2.48	2.07	1.75	1.52	1.26	4.01	2.96	2.27	1.73	1.39
0.9	2.64	2.20	1.85	1.59	1.29	4.46	3.28	2.48	1.84	1.44
1.0	2.78	2.33	1.95	1.66	1.33	4.90	3.59	2.68	1.96	1.50
1.1	2.91	2.45	2.04	1.73	1.36	5.34	3.91	2.90	2.07	1.56
1.2	3.03	2.56	2.13	1.80	1.39	5.76	4.23	3.11	2.19	1.62
1.3	3.13	2.67	2.23	1.87	1.43	6.17	4.55	3.34	2.32	1.68
1.4	3.23	2.77	2.31	1.94	1.47	6.56	4.86	3.56	2.45	1.74
1.5	3.31	2.86	2.40	2.00	1.50	6.93	5.17	3.78	2.58	1.80
1.6	3.38	2.95	2.48	2.07	1.54	7.29	5.47	4.01	2.71	1.87
1.7	3.45	3.03	2.56	2.14	1.57	7.63	5.77	4.23	2.84	1.93
1.8	3.51	3.10	2.64	2.20	1.61	7.95	6.06	4.46	2.98	2.00
1.9	3.56	3.17	2.71	2.27	1.64	8.26	6.34	4.68	3.12	2.07
2.0	3.60	3.23	2.78	2.33	1.68	8.55	6.61	4.90	3.26	2.14

AML

Number of samples = 4

CV = 0.6

AML = 95th percentile value

AML = 4.8 TUc x 1.55 = 7.4 TUc

EPA

Variances to Water Quality-Based Effluent Limits

Learning Objectives

- Describe the types of variances from water quality standards
- Discuss how variances affect water quality-based effluent limits
- Explain the role of the permit writer

EPA

Types of Water Quality Variances

- Site-specific modification of water quality criteria
  - Permanent change in criteria
  - Designated uses maintained
- Designated use reclassification
  - Permanent change in water quality standard
  - Use and criteria change

EPA

Types of Water Quality Variances
(Continued)

- Water quality standard variance
  - Short-term and temporary change to standard
  - Basic water quality standards remain in place
  - Pollutant and discharger specific (sometimes same variance for entire water body)

EPA

Affect of Variances on Permit Limits

- Changes the fundamental basis of water quality-based effluent limits
  - May impact reasonable potential determination
  - May result in more or less stringent limitations
- Role of permit writer
  - Ensure that variance is reflected in permit

Monitoring and Reporting Conditions

Learning Objectives

- Describe purpose of monitoring conditions
- Discuss the considerations for establishing monitoring conditions
- Explain analytical method requirements
- Describe reporting requirements

Purpose of Monitoring

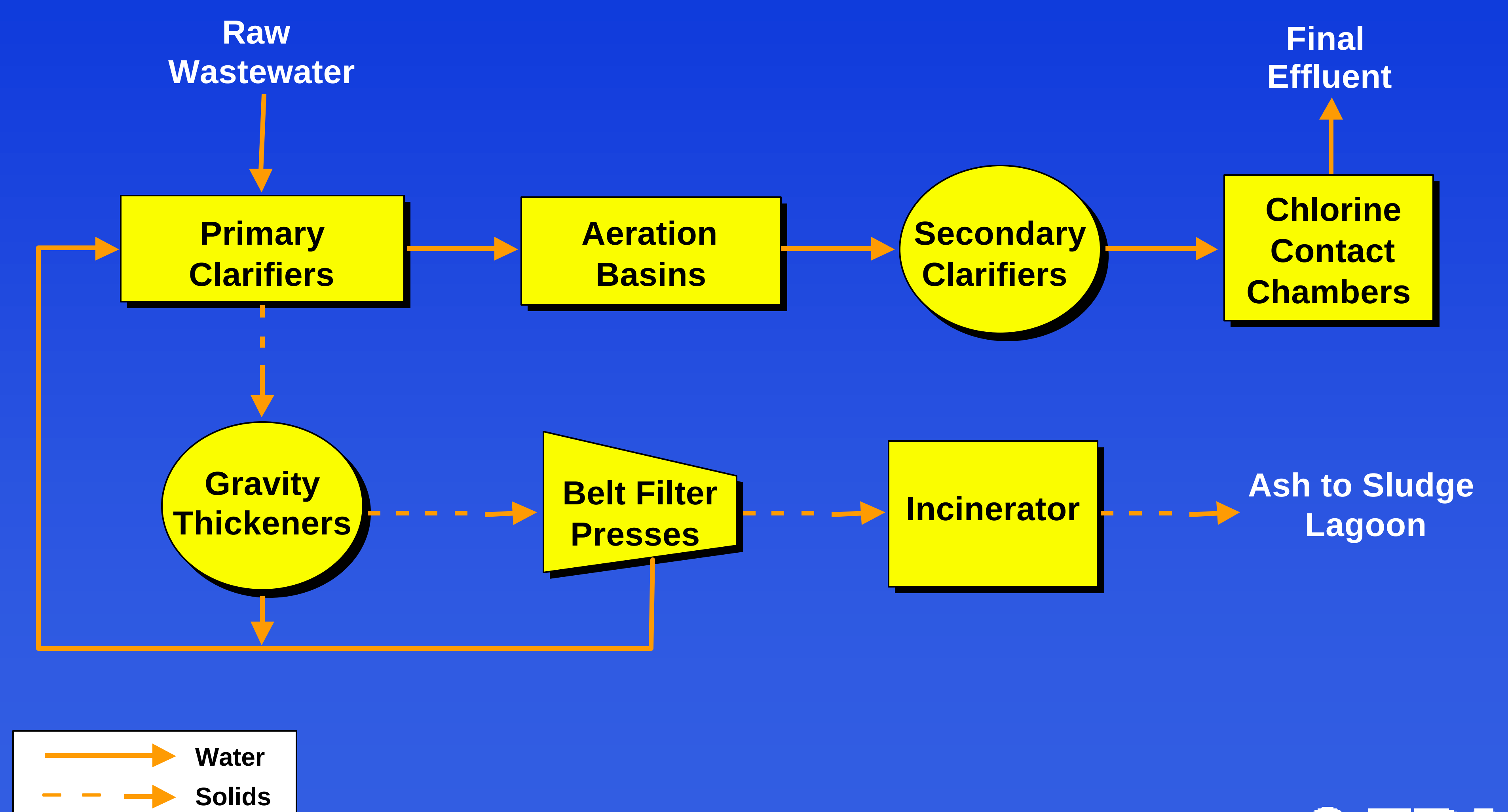
- Determine compliance with permit conditions
- Establish a basis for enforcement actions
- Other
  - Assess treatment efficiency
  - Characterize effluents
  - Characterize receiving water

EPA

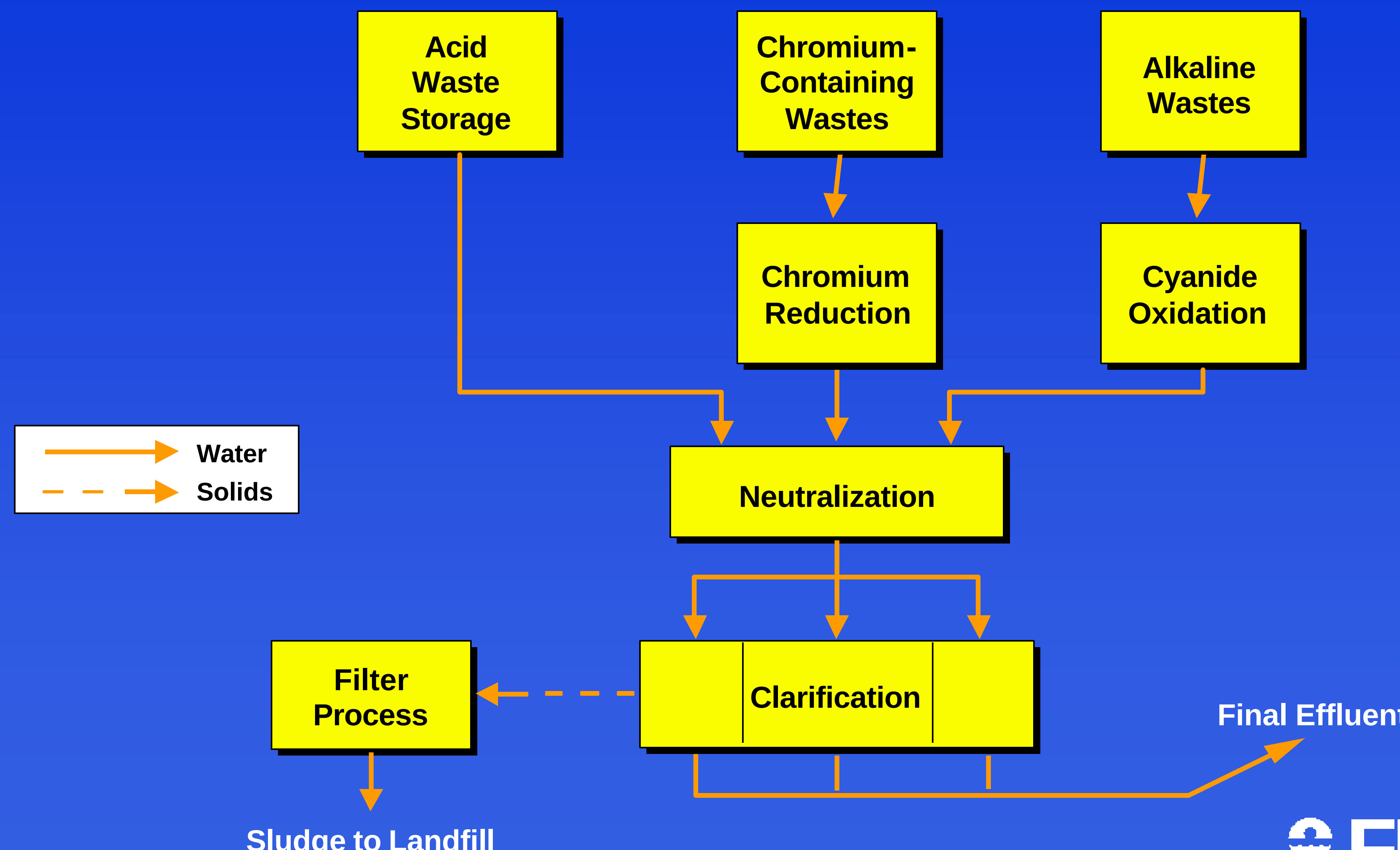
Types of Monitoring

- Self monitoring
  - Permittee performs sampling and analysis
- Compliance monitoring
  - Permitting authority monitors effluent during compliance inspection

Example POTW: Flow Diagram



Example: Industrial Flow Diagram



Self Monitoring Considerations

- Location
- Frequency
- Type of sample
- Cost

Considerations for Monitoring Location

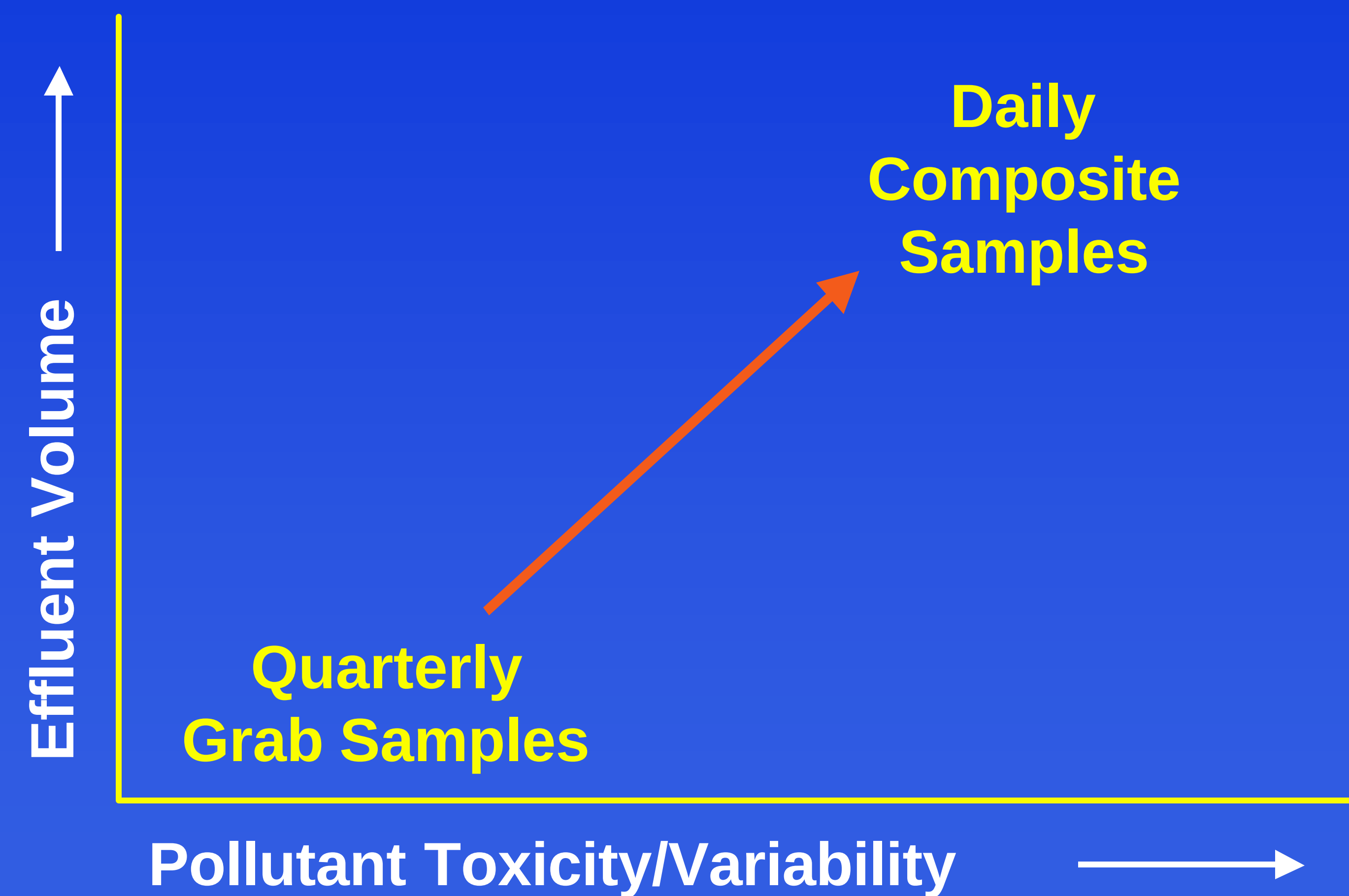
- Is it on the facility's property?
- Is it accessible?
- Will the results be representative of the targeted wastestream?
- Are internal monitoring points needed?

EPA

Frequency Considerations

- Size and design of facility
- Type of treatment
- Location of discharge
- Frequency of discharge (batch, continuous)
- Compliance history
- Nature of pollutants
- Number of monthly samples used in developing permit limit

Frequency Considerations (cont)

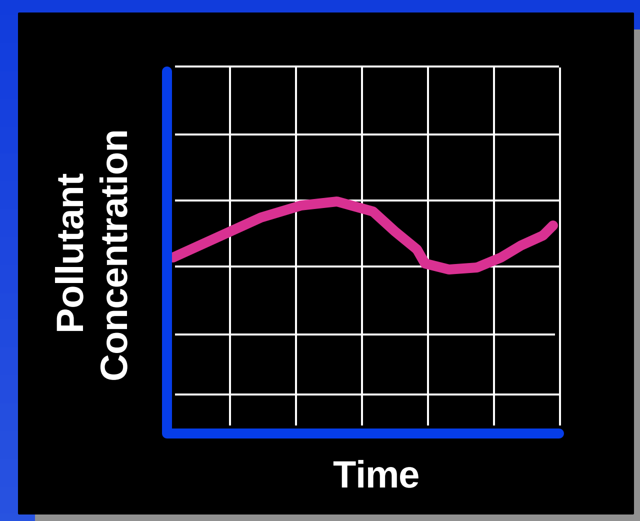


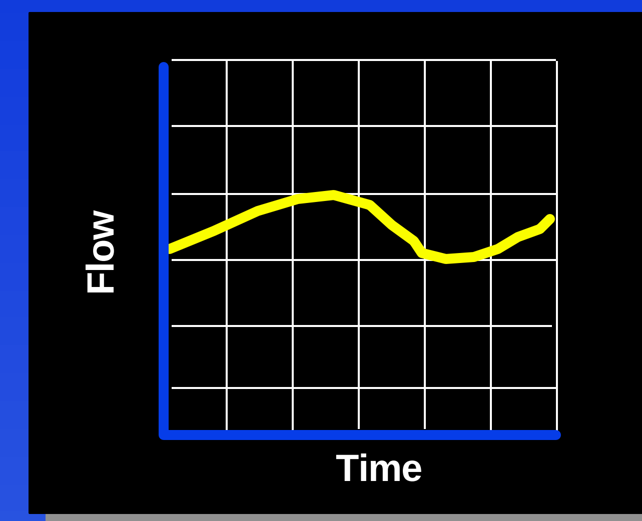
Types of Samples

- **Grab Sample: Taken from a wastestream on a one-time basis without consideration of the flow rate of the wastestream and without consideration of time**
  - **Must be used to monitor certain parameters (e.g., pH, volatile organics, cyanide)**
  - **Used for monitoring batch discharges**

EPA

Example Situation – Case #1





- Slight daily fluctuation in pollutant concentration and flow
- Recommendation: Grab Sample

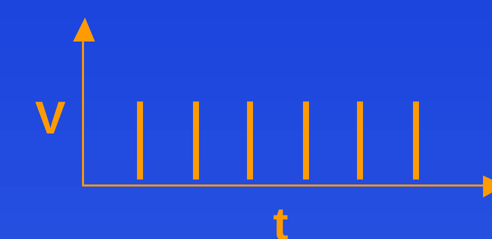
EPA

Types of Samples (Continued)

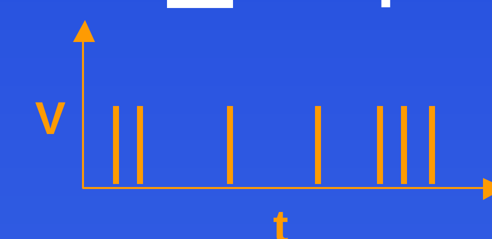
- Composite: Sample composed of two or more discrete aliquots. The aggregate sample will reflect the average water quality over the sample period.
  - More representative measure of the discharge of pollutants over a given period of time
  - Accounts for variability in pollutant concentration and discharge flow rate
  - May be sequential discrete samples or a single combined sample

Types of Samples (Continued)

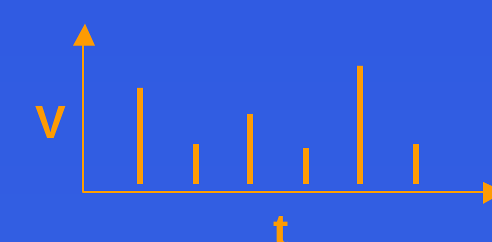
- Composite Sample is defined by the time interval between aliquots, and the volume of each aliquot (t, V).
  - Time Proportional (t_c, V_c): Interval time and sample volume are constant



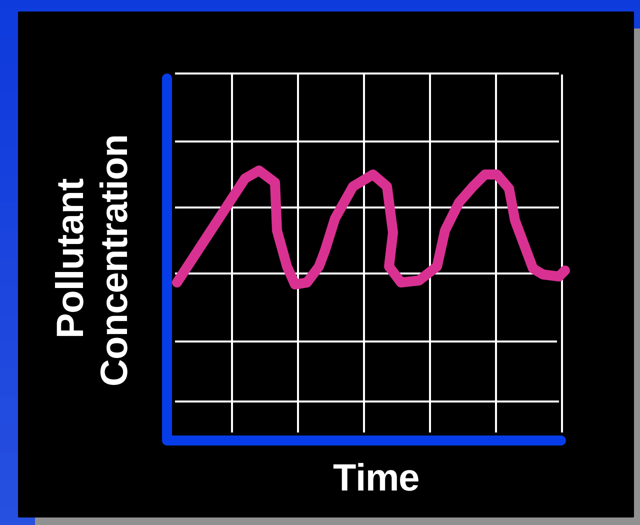
  - Flow Proportional: Interval time or sample volume may vary
    - Constant volume (t_v, V_c)

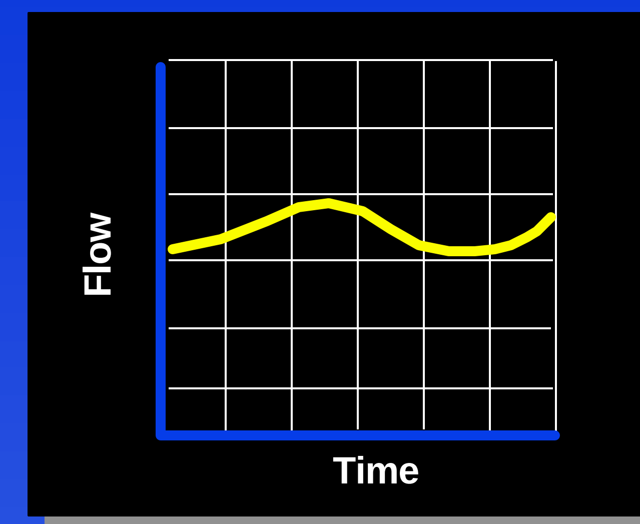


    - Constant time (t_c, V_v)



Example Situation – Case #2

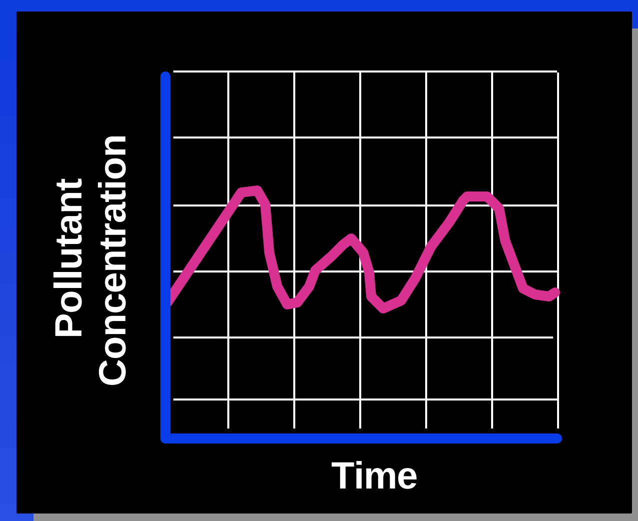


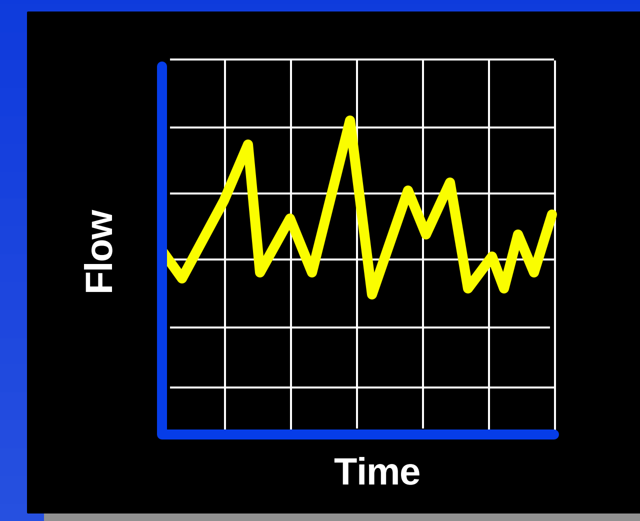


- Regular fluctuations in pollutant loading over the course of the day
- Very slight fluctuations in flow
- Recommendation: Time Proportional Composite

EPA

Example Situation – Case #3





- Irregular fluctuations in pollutant loading over the course of the day
- Erratic fluctuations in flow
- Recommendation: Flow Proportional Composite

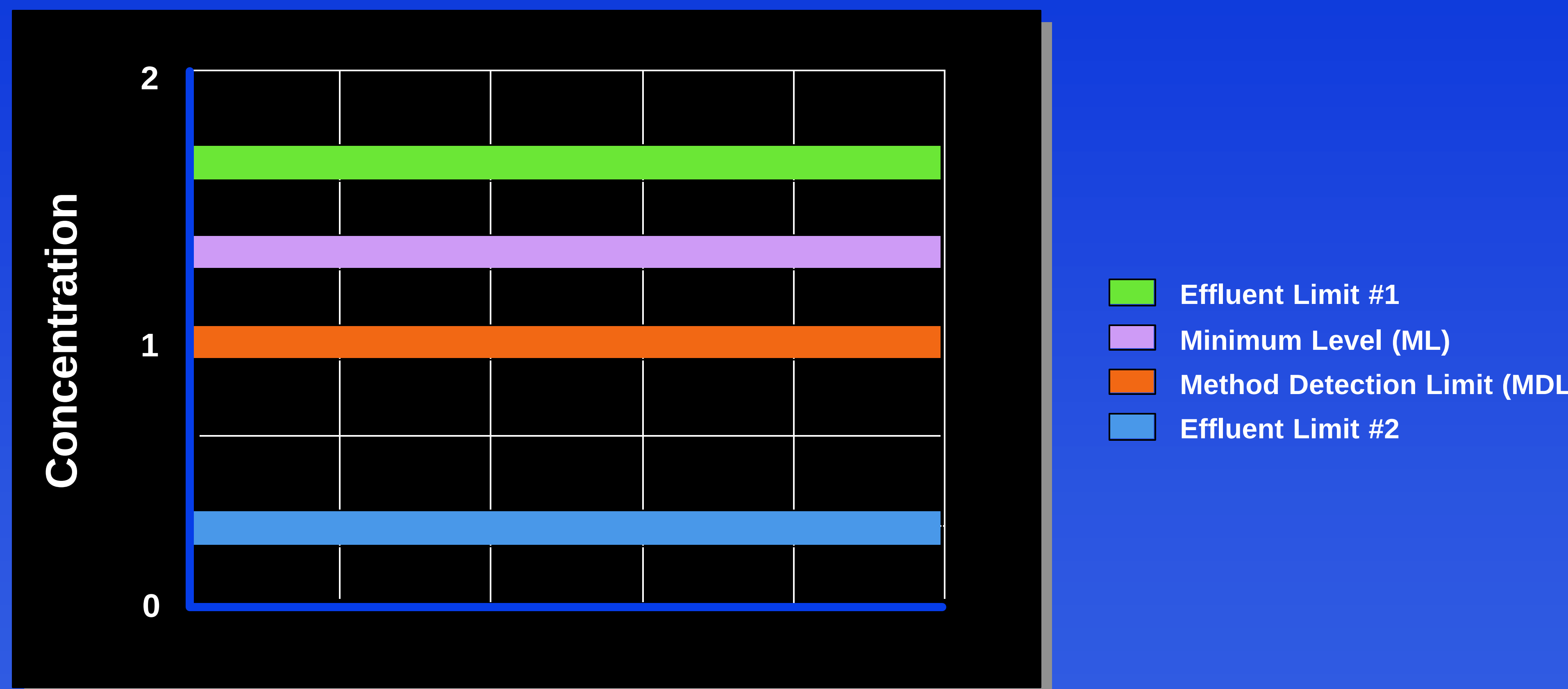
Types of Samples (Continued)

- Continuous Sample: Automated collection and analysis of a parameter in a discharge
  - Typically used for pH and flow
  - 40 CFR § 401.17 allows excursions for pH

Analytical Methods

- 40 CFR Part 136
  - Test methods in Appendix A to Part 136
  - Standard Methods for the Analysis of Water and Wastewater
  - Methods for the Chemical Analysis of Water and Wastes
  - Test Methods: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater
- Alternative methods

Analytical Detection Level Considerations



- Compliance with Limit #1 → 40 CFR Part 136
- Compliance with Limit #2 → ? ? ?

Estimated Costs for Analytical Procedures

BOD5	$30
TSS	$15
TOC	$60
Oil and Grease	$35
Odor	$30
Color	$30
Turbidity	$30
Fecal coliform	$15
Metals (each)	$15
Cyanide	$35
Gasoline (Benzene, Toluene, Xylene)	$100
Purgeable Halocarbons (EPA Method 601)	$113
Acrolein and Acrylonitrile (EPA Method 603)	$133
Purgeables (EPA Method 624)	$251
Phenols (EPA Method 604)	$160
Organochlorine Pesticides and PCBs (EPA Method 608)	$157
Polynuclear Aromatic Hydrocarbons (EPA Method 610)	$175
Dioxin (2, 3, 7, 8-TCDD) (EPA Method 613)	$400
Base/Neutrals and Acids (EPA Method 625)	$434
Priority pollutant scan*	$2,000
TCLP	$150
Acute WET	$750
Chronic WET	$1,500

* Includes 13 metals, cyanide, dioxin, volatiles (purgeables), base/neutral and acids, pesticides and PCBs, and asbestos

EPA

Example #1: Annual Analytical Costs

	Times Per Year	Unit Cost ($)	Annual Cost ($)
BOD5	104	30	3,120
TSS	104	15	1,560
Fecal Coliform	104	15	1,560
Oil and Grease	104	35	3,640
		Total	9,880

Example #2: Annual Analytical Costs

Pollutant	No. Samples	Cost/ Sample	Cost/ Year
Priority Pollutants	4	$2,000	$8,000
Acute WET	4	$750	$3,000
Phenols	12	$160	$1,920
Cyanide	52	$35	$1,820
BOD5	156	$30	$4,680
TSS	156	$15	$2,340
Metals (Ni, Cr, Cu, Pb, Zn)	780	$15	$11,700
		Total	$33,460

EPA

Reporting of Monitoring Results

- **What is reported?**
  - Data required in permit
  - Data for pollutants monitored more frequently than required
- **When is information reported?**
  - At least 1/year for limited pollutants
- **Who is responsible for reporting?**
  - The Permittee
- **What format is used for reporting?**
  - Discharge Monitoring Reports

EPA

Discharge Monitoring Reports (DMRs)

- Must be used to report self-monitoring data
  - Required at 40 CFR §122.41(1)(4)(i)
  - States may alter format

Record Keeping

- Records of monitoring must be kept for 3 years
  - Records for sewage sludge use and disposal activities must be kept for 5 years
- Monitoring records include:
  - Data, place, and time
  - Individual performing sampling
  - Date of analysis
  - Individual performing analysis
  - Analytical methods used
  - Analytical results
- Permit should specify where records should be located

EPA

Special Conditions

Special Conditions are Used in NPDES Permits to...

- Address unique situations
- Incorporate preventative requirements
- Incorporate compliance schedules
- Incorporate other NPDES programmatic requirements (e.g., pretreatment, sewage sludge)

Types of Special Conditions

- Additional monitoring/studies
- Best management practices (BMPs)/pollution prevention
- Compliance schedules

EPA

Additional Monitoring/Studies

- Used to supplement effluent limits
- Used to collect data for future limit development
- Examples:
  - Dilution studies
  - Sediment samples
  - Bioconcentration studies
  - TIE/TRE

EPA

Definition of Best Management Practices

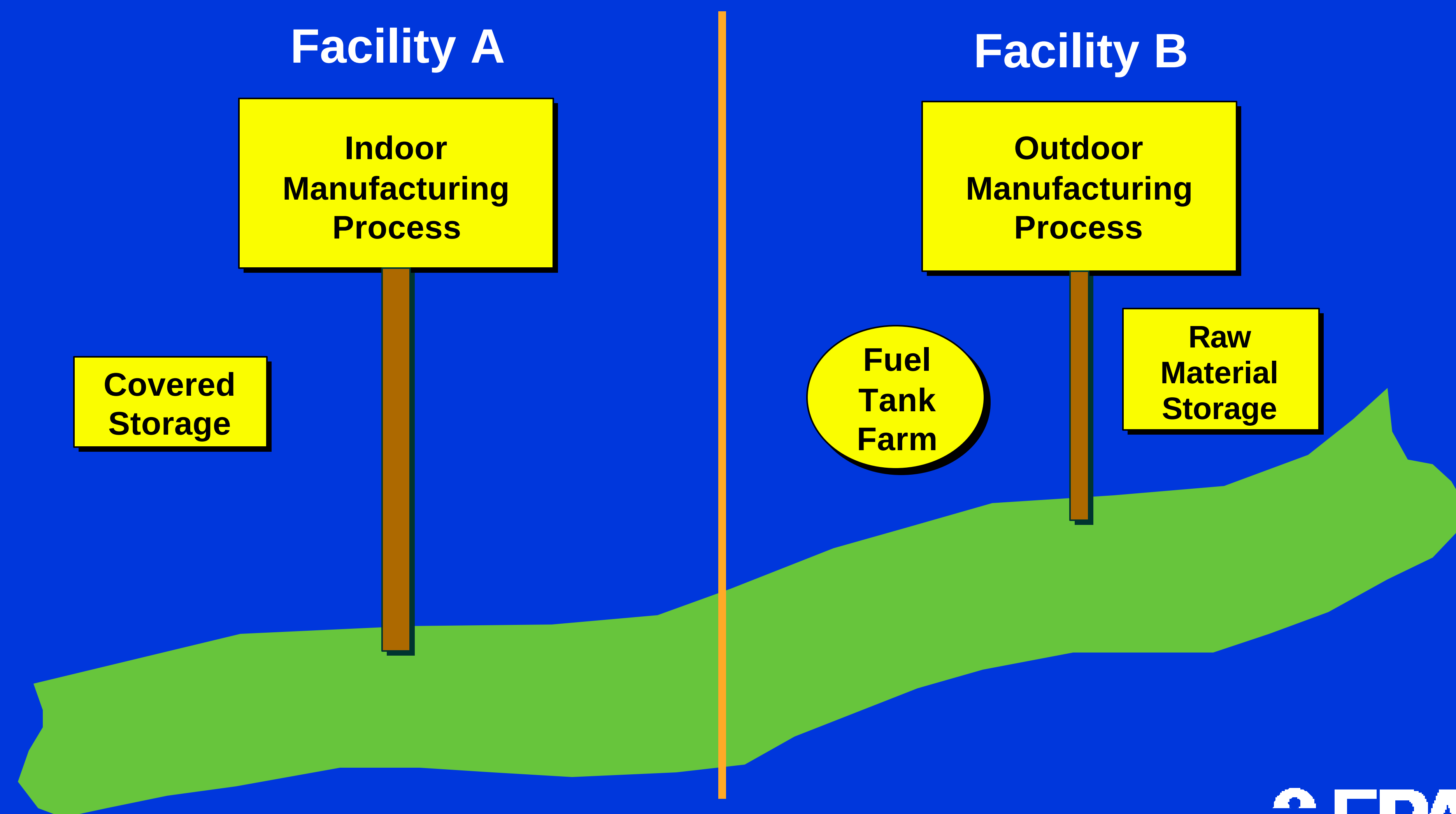
Best management practices (BMPs) are <u>actions or procedures</u> to prevent or minimize the potential for the release of toxic pollutants or hazardous substances in significant amounts to surface waters

Authority for Best Management Practices

- CWA §304(e)
  - Effluent limitations guidelines
- CWA §402(a)(1)
  - Case-by-case basis
  - 40 CFR122.44(k)

EPA

BMP Candidates?



BMPs in NPDES Permits

- BMP plan
- Site-specific BMPs
  - Facility-specific
  - Pollutant-specific
- BMPs should NOT
  - Substitute for quantitative controls
  - Tell managers how to run their plants
  - Require costly methods

EPA

Recommended Elements of a BMP Plan

- Recommended elements
  - Name and location of facility
  - Statement of BMP policy and objectives
  - Review by plant manager
  - BMP committee
  - Risk identification and assessment
  - Reporting of BMP incidents
  - Materials compatibility
  - Good housekeeping
  - Preventive maintenance
  - Inspections and records
  - Security
  - Employee training

Specific BMPs Are...

- Most effectively used in conjunction with effluent limitations in permits
- Qualitative -- should generally indicate how or what, not how much
- Procedural

Examples of BMPs

- Water conservation/ non-use
- Secondary containment
- Nondestructive testing
- Materials engineering
- Covering
- Sealing
- Packaging
- Waste stream segregation
- Source Elimination
- Alarm systems
- Diverting
- Paving
- Runoff control
- Sludge management
- Monitoring
- Security

Pollution Prevention and Special Conditions

- Hierarchy of pollution prevention practices
  - Source reduction
  - Environmentally sound reuse and recycling
  - Treatment
  - Disposal
- Pollution prevention measures may be implemented through BMPs

Compliance Schedules

- **40 CFR §122.47**
  - **Allows for establishing schedules of compliance with CWA and regulations**
  - **Compliance schedule length**
    - **Requires compliance "as soon as possible"**
    - **Interim dates if schedule exceeds 1 year from permit issuance**
    - **Reporting 14 days following each interim date**

EPA

Compliance Schedule Considerations

- Technology based limits
  - Not generally – compliance deadlines
  - New effluent guidelines may allow
- Water quality based limits
  - Starkist Decision
    - WQS must specify
    - WQS adopted since July 1, 1977

EPA

Special Conditions for Municipal Dischargers

Learning Objectives

- Define pretreatment program requirements
- Define sewage sludge requirements
- Define combined sewer overflow requirements

Domestic Sewage Exclusion

- Domestic sewage or any mixture of domestic sewage and other wastes that pass through a sewer system to a POTW ***are not*** considered "solid waste" under RCRA...
- Unless received at the POTW by:
  - Truck
  - Rail
  - Dedicated pipeline

EPA

National Pretreatment Program

- Major goal is controlling discharges in order to:
  - Prevent interference with POTW processes
  - Prevent pass through of pollutants
  - Protect sludge management options
- Additional programmatic goals
  - Encourage recycling and reclamation
  - Ensure POTW personnel health and safety

EPA

Regulatory Requirements – General Pretreatment Regulations (40 CFR PART 403)

- Elements:
  - National Pretreatment Standards
  - Requirements for POTW and State programs
  - Industrial and POTW reporting requirements
- Effluent Limitations Guidelines (40 CFR 405-471)
  - Including categorical pretreatment standards

Pretreatment Program Development

- **Who?**
  - POTWs > 5 MGD
  - POTWs < 5 MGD with past problems
- **What?**
  - Legal authority
  - Industrial user survey
  - Individual control mechanisms for all SIUs
  - Compliance/enforcement
  - Resources
  - Data management

EPA

NPDES Permits Drive the Pretreatment Program by Requiring:

- Adequate legal authority
- Maintaining industrial user inventory
- Development/implementation local limits
- Individual control mechanisms be issued to all SIUs
- Compliance monitoring activities

EPA

NPDES Permits Drive the Pretreatment Program by Requiring:

- Swift and effective enforcement
- Data management and recordkeeping
- Reporting to the approval authority (EPA or State)
- Public participation

EPA

Permits for Municipal Sewage Sludge (Biosolids)

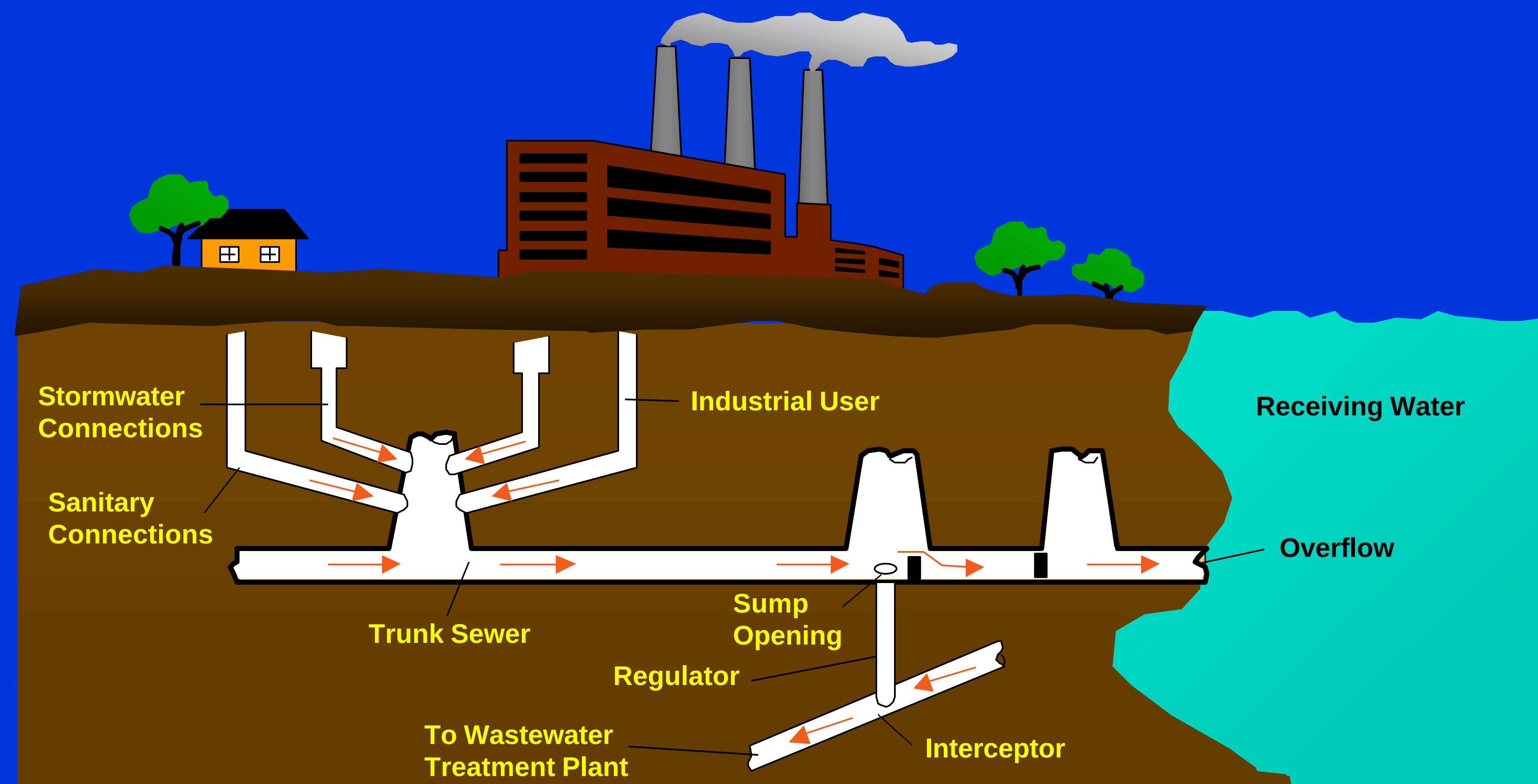
- Any Section 402 permit issued to a POTW should contain requirements for sewage use and/or disposal
- 40 CFR Part 503 requirements should be incorporated into a permit for:
  - Incineration
  - Land application
  - Surface disposal

EPA

Permits for Municipal Sewage Sludge (Biosolids) (Continued)

- Other entities may be delegated responsibility to comply (40 CFR Part 503 standards and requirements may not all be placed in the POTW permit)
- Permits must contain:
  - Additional standard conditions
  - Special conditions

Typical Combined Sewer System Configuration



EPA

Requirements for Combined Sewer Overflows (CSOs)

- **Technology-based requirements (BPJ)**
  - **BAT (none promulgated)**
  - **BCT (none promulgated)**
- **Applicable State water quality standards**

EPA

Considerations for Developing Special Conditions for CSOs

- Characteristics of the discharge
- Control technologies
- CSO control policy

Overview of CSO Control Policy Approach

Years after Phase I Permit Issuance

Time	0 →	5 →	10+ →
NPDES Permit Requirements	**Phase I**	**Phase II**	**Post Phase II**
A. Technology-Based	◆ Nine minimum controls (NMC), at a minimum	◆ NMC, at a minimum	◆ NMC, at a minimum
B. Water Quality-Based	◆ Narrative	◆ Narrative + performance-based standards	◆ Narrative + performance-based standards + numeric WQ-based effluent limits (as appropriate)
C. Monitoring	◆ Characterization, monitoring, and modeling of CSS	◆ Monitoring to evaluate WQ impacts ◆ Monitoring to determine effectiveness of CSO controls	◆ Post-construction compliance monitoring
D. Reporting	◆ Documentation of NMC implementation ◆ Interim long-term control plan (LTCP) deliverables	◆ Implementation of CSO controls	◆ Post-construction compliance monitoring reporting
E. Special Conditions	◆ Prohibition of dry weather overflows (DWO) ◆ Development of LTCP	◆ Prohibition of DWO ◆ LTCP implementation schedule ◆ Reopener clause for WQS violations ◆ Sensitive area reassessment	◆ Prohibition of DWOs ◆ Reopener clause for WQS violations

Standard Conditions of NPDES Permits

Learning Objectives

- Describe the role of "boilerplate" language
- Discuss methods for placing standard conditions in permits
- Review the types of standard conditions

Standard Conditions in the Permit

- 40 CFR §122.41 - Conditions applicable to all permits
- 40 CFR §122.42 – Additional conditions applicable to specified categories of NPDES Permits
- Must appear in <u>every</u> NPDES permit
  - Expressly (verbatim)
  - By reference

EPA

List of Standard Conditions – 40 CFR §122.41

a. Duty to comply
b. Duty to reapply
c. Need to halt or reduce activity not a defense
d. Duty to mitigate
e. Proper O & M
f. Permit actions
g. Property rights
h. Duty to provide information
i. Inspections and entry
j. Monitoring and records
k. Signatory requirement
l. Reporting requirements
    1. Planned change
    2. Anticipated noncompliance
    3. Transfers
    4. Monitoring reports
    5. Compliance schedules
    6. 24 hour reporting
    7. Other non-compliance/information
m. Bypass
n. Upset

Additional Standard Conditions - 40 CFR §122.42

- Notification levels for existing non-municipal dischargers
  - Requirement for toxic pollutants not limited in permit
  - Discharged on routine or frequent basis
  - Discharged on non-routine or infrequent basis
- Notification for POTWs
  - New significant indirect discharger
  - Change in pollutant volume or character
- Annual report for municipal separate storm sewer systems
- Compliance within three years for initial storm water permits

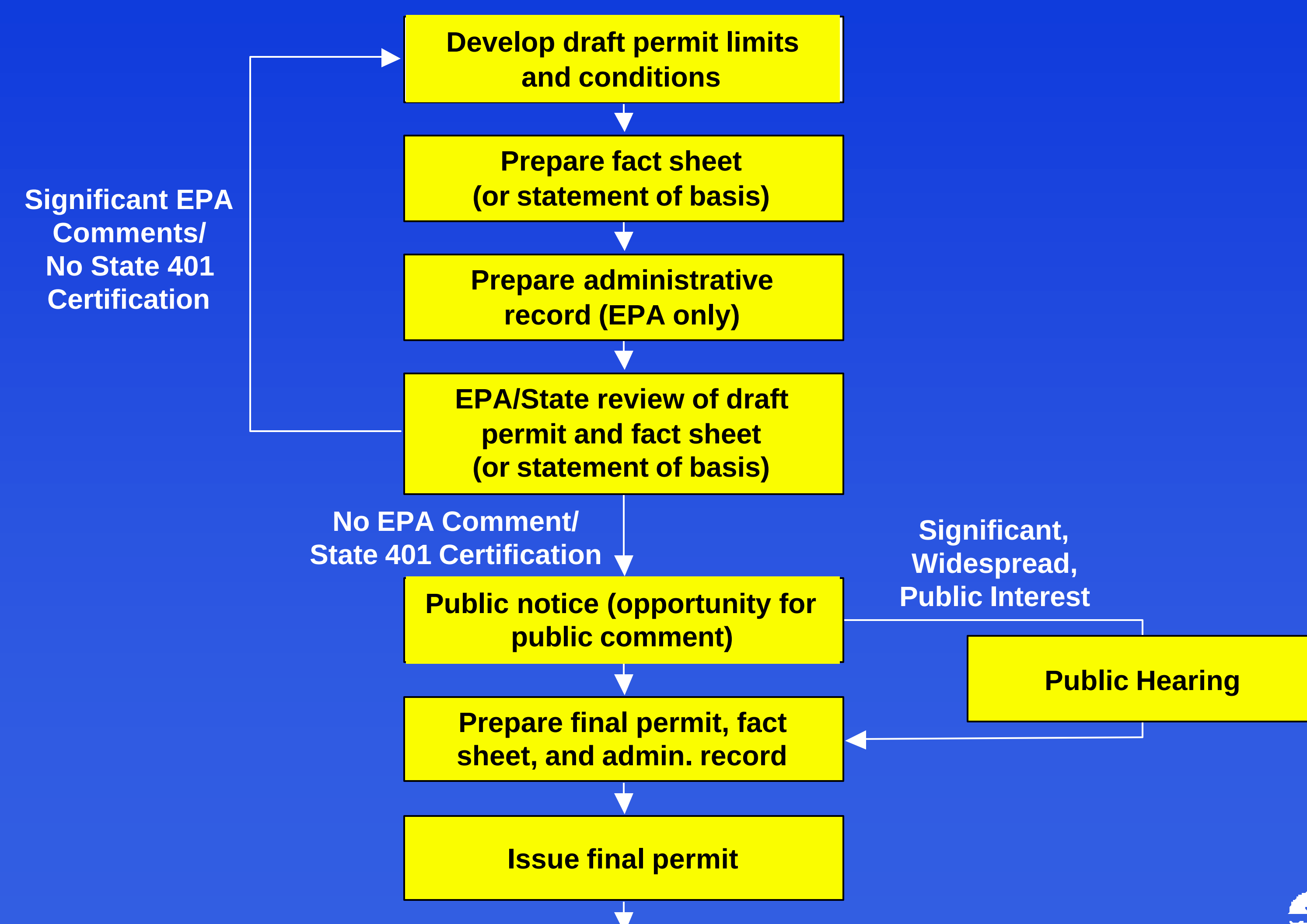
EPA

Administrative Process

Learning Objectives

- Describe NPDES permit administrative procedures
- Discuss requirements and need for documentation
- Explain public participation requirements
- Describe administrative activities after final permit issuance

NPDES Permitting Process



NPDES Permitting Process (Continued)

Issue final permit

↓

Formal appeal to Environmental Appeals Board

↓

Environmental Appeals Board Decision

↓

Final Agency Action

NPDES Administrative Process

- The administrative process of developing and issuing a permit involves:
  - Documenting all permit decisions
  - Coordinating EPA and State review of the draft permit
  - Providing public notice, conducting hearings (if appropriate), and responding to comments
  - Defending the permit and modifying after issuance (if required)

EPA

Reasons for Good Documentation

- Establishes permanent record of the basis for the permit
- Explains legal basis of permit
- Provides sound basis for future modifications and permits
- Requires permit writer to be organized and logical throughout permit development process

EPA

Contents of Administrative Record - Draft Permit

- What is it?
- What is in it?
  - Application and supporting data
  - Draft permit
  - Statement of basis or fact sheet
  - Documents/items cited in statement of basis or fact sheet
  - Other items supporting permit development
  - Environmental Impact Statement (EIS) for new source draft permits

Fact Sheet vs. Statement of Basis

Fact Sheet	Statement of Basis

Fact Sheet

- Permit involves a major facility
- Permit incorporates a variance
- Permit is an NPDES general permit
- Permit is subject to widespread public interest

Statement of Basis

- Used when fact sheet not required
- Requires:
  - Description of conditions
  - Reasons for conditions

Minimum Elements of a Fact Sheet

- General facility information
  - Description of facility or activity
  - Sketch or description of location
  - Type and quantity of waste/pollutants discharged
- Summary rationale of permit conditions
  - Applicable statutory/regulatory citations
  - References to administrative record

Minimum Elements of a Fact Sheet
(Continued)

- Detailed rationale of permit conditions
  - Explanation and calculation of effluent limitations and conditions
  - Specific explanation of:
    - Toxic pollutant limits
    - Limits on internal wastestreams
    - Case-by-case requirements
    - Limits on indicator pollutants
    - Regulation of users (Non-POTWs only)
  - Sewage sludge land application plan
  - Inappropriateness of requested variances

EPA

Minimum Elements of a Fact Sheet
(Continued)

- **Administrative Requirements**
  - Permit procedures
    - Comment period begin and end dates
    - Procedures for requesting a hearing
    - Public involvement in final decision
  - Permitting authority contact name and telephone

EPA and State/Tribal Roles

- State/Tribal issued permits
  - EPA retains the right to review:
    - Major municipal and industrials
    - General permits
    - Class I sludge facilities
  - EPA reviews other significant permits (minor)
- EPA issued permits
  - State/Tribal Section 401 certification required
    - Certifies that permit will achieve water quality standard

Public Notice

- Purpose of public notice
- Types of actions requiring public notice
  - Tentative denial of application
  - Draft NPDES permit
  - Public hearing
  - Formal appeal of permit (after issuance)
  - Major permit modifications (after issuance)
  - Granting of evidentiary hearing (after issuance)

EPA

Public Notice (Continued)

- Methods applicable to public notice process
  - Publication in newspaper
  - Direct mailing
- Contents of public notice
  - Name and address of regulatory authority
  - Name and address of permittee
  - Brief description of facility
  - Name, address, and telephone of contact
  - Additional information (EPA-issued permits)

EPA

Public Notice (Continued)

- Timing of public notice
  - Must allow at least 30 days for public comments
  - EPA/State MOA may specify EPA review of either draft or proposed permit
- Responding to comments
  - Significant comments must be responded to in writing

Public Hearings

- Public hearings may be requested by any party
- Hearings are optional
- Scheduling the hearing automatically extends the comment period until the close of the hearing [40 CFR §124.12(c)]
- A transcript of the hearing must be available to interested persons

Contents of Administrative Record - Final Permit

- Administrative record of draft permit
- All comments received
- Public hearing tape or transcript
- Response to comments
- Final EIS for new sources
- Final permit

EPA

After Final Permit Issuance

- Permit appeals
- Minor/major permit modifications
- Permit termination
- Permit Transfer

EPA

Permit Appeal (40 CFR 124.19)

- Used by permittee to contest final permit limits and conditions
- Must be requested within 30 days following final permit issuance
  - Challenges limited to issues raised during public comment on draft permit (unless good cause is shown)
- EAB decides to grant/deny request
- Public notice of appeal required
- Only contested permit conditions are stayed

Permit Appeal Continued

- Permit writers' role during appeal
  - Source of technical knowledge for attorney

Minor Modifications

- Used to make corrections to permit conditions with consent of the permittee
- Exempt from administrative procedures (i.e., draft permit, public notice, etc.)
- Actions considered minor:
  1. Typographical errors
  2. More frequent monitoring
  3. Change in interim compliance date (<120 days)
  4. Change in ownership
  5. Change in construction schedule for new source
  6. Deletion of point source outfall
  7. Incorporate approved local pretreatment program

Major Modifications

- Required to address new information that may impact permit conditions
- Administrative procedures must be followed (i.e., draft permit, public notice, etc.)
- Causes for modification:
  1. Reopener condition
  2. Correct technical and legal mistakes
  3. Failure to notify interested State
  4. New information
  5. Alterations justifying new/different conditions

Major Modifications Continued

- **Causes for modification:**
  6. New regulations
  7. Modification of a compliance schedule (>120 days)
  8. Require POTW to develop pretreatment programs
  9. Unsuccessful BPJ treatment installed
  10. Address non-limited pollutants
  11. Variance request
  12. Adjust limits to reflect net pollutant treatment
  13. Insert 307(a) toxic or Part 503 sludge use/disposal
  14. Establish notification levels

Permit Terminations

- Used to retract privilege to discharge during permit term
- Causes for termination:
  - Suspend effectiveness in emergency
  - Terminate for falsifications, recalcitrants or changed conditions (e.g., plant closure)
- Administrative procedures must be followed (i.e., public notice)
  - No public notice is required for termination due to plant closure

EPA

Permit Transfer

- Necessary to address change in owner or operator
- Transfer Options
  - Transfer by modification or revocation and reissuance
  - Automatic transfer
    - Prior 30-day notice
    - Written agreement between new and old owners
    - Permit will not be modified or revoked

What is "Anti-backsliding?"

- Provision of the Clean Water Act found at Section 402(o) (repeated at 40 CFR 122.44(l))
- Prohibits renewing, reissuing, or modifying a permit to contain less stringent effluent limits than comparable limits in the previous permit
- Some exceptions permitted

Application of Anti-backsliding

Anti-backsliding provisions apply to:

- BPJ technology-based limits for which effluent guidelines promulgated later would result in a less stringent effluent limit
- Limits based on State standards (water quality standards, State treatment standards)

All Other Limits and Permit Conditions

- Anti-backsliding provisions in CWA 402(o) do not apply
- Permit may be modified if circumstances upon which previous permit conditions were based have materially and substantially changed since last permit was issued and would constitute cause for modification under 40 CFR 122.62

EPA

Anti-backsliding Exceptions for BPJ Limits

Backsliding to less stringent effluent guideline is permissible under the following conditions:

- Must meet one of the 402(o)(2) exceptions (also listed in 40 CFR 122.44(l)(2))
- New limit must be consistent with applicable effluent guidelines and not result in a violation of water quality standards

Anti-backsliding Exceptions for Limits Based on State Standards

Two options under which backsliding is permissible

- Option 1: 402(o)(2) exceptions
- Option 2: 303(d)(4) exceptions

Exceptions for Limits Based on State Standards

Option 1 – 402(o)(2) exceptions

- Must meet one of the applicable 402(o)(2) exceptions (*Note that exceptions B(2) and D do not apply to limits based on State standards*)
- New limit must be consistent with applicable technology-based requirements and not result in a violation of water quality standards

Exceptions for Limits Based on State Standards

Option 2 – 303(d)(4) exceptions

- Discharges to Attained Waters
  - Revised limit must be consistent with applicable effluent guidelines and water quality standards

- Discharges to Non-Attained Waters
  - Existing limit must be based on a TMDL or WLA
  - Cumulative effect of all revised limits must assure attainment of water quality standards
  - Revised limit must be consistent with applicable technology-based requirements

EPA